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EFFECTS OF LOW-ALTITUDE AIRCRAFT OVERFLIGHTS ON DOMESTIC TURKEY POULTS

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This report has been reviewed and is approved for publication.

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This study involved a series of experiments on the effects of aircraft overflights and simulated overflight noise on commercial meat turkeys. Experiments sought to quantify the relation between sound characteristics of overflights and turkey responses, to determine how rapidly naive turkeys habituate, to determine whether simulated aircraft noise is an adequate model for real aircraft, and to measure effects of chronic worst-case exposure on weight-gain, mortality and carcass quality in turkeys reared under commercial conditions. Results found that turkeys habituate very rapidly to both actual and simulated aircraft noise of high amplitude; that the most useful predictor of responses appeared to be the sound exposure level; that there were no marked differences between the exposures to actual overflights versus simulated aircraft noise; that turkeys exposed to chronic worst-case grew at the same rate vs. controls, but had some behavioral differences and were somewhat more difficult to handle; and that some loss was observed due to picking in the experimental group.

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FOREWORD

This study was prepared by personnel from the University of California at Davis, Department of Avian Sciences and from the Sea World Research Institute, Hubbs Marine Research Center. The Hubbs Marine Research Center is a member of the BBN Systems and Technologies Corporation (BBN) team of experts engaged in research on Noise and Sonic Boom Impact Technology (NSBIT).

The NSBIT program is conducted by the United States Air Force, Air Force Systems Command, Human Systems Division, and is under the direction of Major Robert Kull, Jr., Program Manager. The BBN effort is conducted under Contract No. F33615-86-C-0530 and is under the direction of Mr. B. Andrew Kugler, Program Manager. The work reported herein is in fulfillment of Task Order 0022.

EXECUTIVE SUMMARY

The Department of Avian Sciences at the University of California at Davis (UCD) and the Hubbs Marine Research Center (Hubbs) conducted a series of experiments on the effects of aircraft overflights and simulated overflight noise on commercial meat turkeys. Commercial meat turkeys were chosen as subjects because they are extremely uniform genetically and because their responses to disturbance are reputedly damaging. These experiments were intended to quantify the relation between sound characteristics of overflights and turkey responses (Experiments 1, 2, and 3), to determine how rapidly naive turkeys habituate (Experiments 1, 2 and 3), to determine whether simulated aircraft noise is an adequate model for real overflights (Experiment 2), and to measure effects of chronic worst-case exposure on weight gain, mortality and carcass quality in turkeys reared under commercial conditions (Experiment 3). UCD conducted a short pilot survey to determine whether low-altitude overflights cause problems in actual commercial practice and whether piling and crowding, a dangerous response to disturbance, occurs frequently. Finally, the results were verified and analyzed for inclusion in the model on domestic poultry in the Assessment System for Aircraft Noise (ASAN), a tool for environmental impact assessment.

The experiments consisted of the following:

Experiment 1: Two groups of 50 each 10-day-old turkeys were exposed to low-amplitude (84 dB sound level) aircraft noise to determine responses and habituation rates. They were then habituated to the same stimulus and exposed to noise stimuli varying in sound level (85 to 115 dB) and onset rate (25 to 60 dB/sec) to determine whether a) the initial exposures habituated them to all aircraft noise, and b) which combinations of sound level and onset rate were most effective at arousing responses. A control group of 50 turkeys was maintained to determine whether exposure altered normal behavior in these young birds.

Experiment 2: Two groups of 7-week-old turkey poults were transported to a site in the Mojave Desert that experiences an average of three, very low-altitude overflights per day. The groups were held in an open pen and a pen covered with an acoustically-transparent opaque barrier. Their responses to overflights were observed for several days, after which a series of exposures to simulated overflights was administered. These experiments were

intended to show whether simulated aircraft overflights are as effective as actual overflights, and whether the visual component of the stimulus in combination with the sound stimuli arouses greater responses.

Experiment 3: Three groups of turkeys (20, 40, and 100 poults) were exposed to worst-case aircraft noise, based on the results of Experiment 1. A matched set of controls was maintained in a separate barn isolated acoustically from the treatment barn. The turkeys were reared from 6 to 17 weeks of age under a regime of 19 exposures per week to aircraft noise with sound levels over 85 dB. Behavioral responses, weight gain, and carcass quality were evaluated at the end of the experimental period. In addition, a short survey was administered to local turkey growers to find out how often they experienced losses due to piling and crowding.

Analysis of Videotapes: The behavioral data collected in Experiments 1 and 3 were analyzed independently with a double-blind scoring system to determine whether behavioral effects could be detected due to exposure to overflights. The data from Experiment 2 were analyzed as well.

Model Integration: The results of Experiments 1-4 were integrated for inclusion in the model of effects on domestic poultry currently implemented in ASAN.

A summary of the most important results follows:

First, the turkeys in these studies habituated very rapidly both to actual and to simulated overflights of high amplitude. Dangerous responses, such as piling and crowding, were extinguished after the first exposure. This finding confirms the results of earlier studies (Stadelman, 1958a; Cottereau, 1972; Von Rhein, 1983), which found extinction of dangerous responses after, at most, three exposures. The rate of habituation varied little with sound level.

Second, the most useful predictor of responses appeared to be the sound exposure level, a measure that depends both on maximum sound level and total duration of the stimulus.

Third, previous exposure to an overflight with sound level below the threshold for dangerous responses was sufficient to extinguish panic responses to sounds of higher level.

Fourth, there were no marked differences between the exposures to actual overflights versus simulated overflights. Although differences between responses by birds in visually-isolated versus open pens were observed, they were due largely to curiosity (the turkeys were more interested in aircraft they could see).

Fifth, turkeys chronically exposed to worst-case noise grew at the same rate as unexposed birds. There were marginal behavioral differences; exposed birds were slightly more active and more aggressive than unexposed birds. Exposed birds were also somewhat more difficult to handle. One or both of these differences resulted in differences in carcass quality attrib· ɔle to small surface lesions and bruising. The economic impact of this bruising varies with operation, but is estimated at 0-50%, depending on the operation, after long-term chronic exposure. A dose-response relation is being developed based on the data collected in Experiment 3, but the effect merits further investigation.

No significant effects on weight gain or total mortality were observed. However, losses due to picking were somewhat elevated in the experimental group. The cause of the picking is unclear, but it is presumed to be the greater activity levels of exposed birds.

ASAN contains a predictive model for the effects of overflights on domestic poultry. This model can be simplified based on the results of these studies, and new models can be integrated for the effects of chronic exposure.

ACKNOWLEDGMENTS

This program would not have been possible without the assistance of many people. Mr. Jon Francine and Ms. Deb Francine risked life and limb to protect turkey poults from a raging 41 thunderstorm during the experiments in the Mojave Desert. Jon also provided invaluable assistance in making sound level measurements and photographing aircraft. Ms. Donna McDonald and Mr. Mark Kinsey dreamed of turkey displacements after analyzing over 360 hours of videotape. Dr. Robert Young provided expert assistance and the loan of a community noise monitor. BBN installed the sound simulation system at U.C. Davis, thanks to the efforts of Mr. Jon Ciarletta and Mr. Paul Chavez. Mr. John Voris took time to administer the survey of turkey growers. Dr. Hans Abplanalp and Ms. Barbara Dierks at with the Department of Avian Sciences provided invaluable administrative assistance. Dr. James Millam made many valuable suggestions about the experimental design. Dr. Kim Joyner provided veterinary care and advice. Dr. Christine Bruhn gave a thoughtful critique of the survey.

1.0 INTRODUCTION

Aircraft noise, in the form of low-altitude overflights and sonic booms, has been suspected of having many serious effects on domestic fowl, including 1) breaking eggs and reducing hatchability, 2) lowering the productivity or productive lifetime of laying hens, 3) inducing crowding, piling and smothering due to panics, and 4) reducing the growth rate of poults. Some of these effects, specifically egg breakage and reduced hatchability, cannot be produced under experimental conditions (Stadelman, 1958b; Heinemann and LeBrocq, 1965; Cottereau, 1972; Teer and Truett, 1973; Bowles *et al.*, 1989). However, occasional deaths and injuries due to panic crowding have been substantiated (Stadelman, 1958a; Milligan *et al.*, 1983). Changes in productivity (slowed weight gain, lowered egg production) have been cited in claims against the U.S. Air Force (USAF; Bowles *et al.*, 1990). Because some of these claims were considered legitimate by USAF veterinarians and because one study contains some evidence (not statistically significant) for a marginal effect on weight gain (Stadelman, 1958a), effects on food consumption, growth rates, and carcass quality should be studied as well.

The clinical reports in the claims, especially those that have been reviewed carefully (Milligan *et al.*, 1983), are at odds with the experimental studies of poultry exposed to aircraft noise. This is true of controlled experiments (Stadelman and Kosin, 1957; Von Rhein, 1983), and spontaneous experiments performed as needed by various air bases (e.g., unpublished videotapes of experiments in Riverside County, CA; Manning pers. comm). In experimental studies, poultry can be stimulated to crowd and pile sometimes, but mortalities are rare. In fact, only one bird is known to have died as a result of crowding in five controlled exposures of over 3,600 birds (Stadelman, 1958a; Von Rhein, 1983). Thus, it is extremely important to develop a simple hypothesis that explains both types of observations.

The purpose of this study, then, has been to determine which features of an aircraft overflight are most disturbing to birds, to develop a predictive model for damages due to crowding, and to determine whether any damages to the commercial value of the birds occur under commercial conditions. Effects during growth have not been substantiated, so these experiments were designed to examine effects of worst-case exposure to aircraft noise.

A preliminary version of a dose-response model for the behavioral responses of poultry was developed based on data in the literature (Bowles *et al.*, 1990) and will be improved by the results of this study. This model is currently implemented in the Assessment System for Aircraft Noise (ASAN; Reddingius and Bowles, 1990), a tool for improving the Environmental Impact Assessment Process (EIAP) as conducted by the USAF.

The domestic turkey was chosen as the subject for this study for various reasons. First, it is regarded as especially prone to crowding, and has been the subject of several very costly claims against the USAF (Bowles *et al.*, 1990). Second, the responses of turkeys have not been studied as yet. Third, turkeys have been bred for large body size and rapid growth, so effects on weight gain are more readily detected. Fourth, turkeys are prone to stress fractures in their legs and to heart failure, both of which might predispose them to stress-related effects. Fourth, most meat turkeys raised in the U.S. are products of a single strain, so that little natural variance is observed in growth rate, making it much easier to detect environmentally-caused variances.

The basic literature on crowding and piling in turkeys is anecdotal, and is oriented to telling the farmer how to avoid the problem. The problem has not received research attention, and losses due to stampedes are not recognized as a source of mortality by industry sources (Warnick, 1988). The causes listed for dangerous crowding and stampedes are predators, strange noises, sudden bright lights at night (Kaupp and Surface, 1947), dampness, cold, malnutrition, disease, overcrowding, improperly designed housing, insufficient shade, or objects that act as a focal point for crowding (Marsden and Martin, 1955). Marsden and Martin provide the following insights related to aircraft noise:

> "Crowding and piling are ways in which turkey poults can be and are frequently lost without warning and in large numbers, especially during the early brooding period... Rats, crows, hawks, dogs, and cats, may cause serious losses, sometimes indirectly through frightening... Low-flying airplanes, unless the birds are used to them, may cause losses from piling."

These documents give no indication of the incidence of crowding and piling in actual practice. A short pilot survey conducted during the course of this study was intended to determine the typical

cause of stampeding and to show whether the incidence is significant from the perspective of turkey growers.

2.0 METHODS

BBN acted as the main contractor on this project, providing the sound simulation system and technical expertise on sound analysis. BBN subcontracted the major portion of the poultry work (Experiments 1 and 3) to the Department of Avian Sciences at the University of California at Davis (UCD). Experiments with real aircraft, independent videotape analysis, and integration of the results of the study into ASAN were subcontracted to the Sea World Research Institute, Hubbs Marine Research Center (Hubbs; Experiments 2, 4, and 5).

2.1 Experiment 1: Determining the Stimuli Most Effective for Startling Naive Turkeys

The poults for Experiments 1-3 were of the broad-breasted white strain of Nicholas Turkey Breeding Farms and were hatched on 14 February 1990. They were introduced into two commercial poultry barns at a site near UCD. The barns were located about 500 m from a roadway experiencing fairly heavy traffic, but were protected from the freeway noise by a low berm. Ambient sound levels in the barns averaged 55 dB before the pens were built, and somewhat less inside the pens. Figure 2-1 shows the relative positions of the two barns. The pens in the control barn were separated from the sound system by a distance of 33 m, two barn walls, the plywood siding of the turkey pens, and a wall of straw bales used as a sound-dampening baffle. Since the noise from the highway and the turkeys was reasonably high, the attenuated sounds from the experimental barn were effectively masked, once the turkeys were introduced. Sound levels emitted by the young poults averaged 75 dB.

One hundred poults were randomly distributed on the day of hatch, half into the control barn and half into the treatment barn. The poults were brooded on pine shavings, and were held under commercial heat lamps at a temperature of 105°F at 3 inches off the floor. Corrugated cardboard circles (approximately 5 feet in diameter) kept the birds near the lamps at all times. Farmers' brand turkey starter and fresh water were provided *ad libitum*. At age seven days, the circle was widened to 10 feet.

The setup of control and experimental barns is shown in Figure 2-1. A sound system custom designed by BBN to simulate aircraft overflights was installed in the experimental barn. The

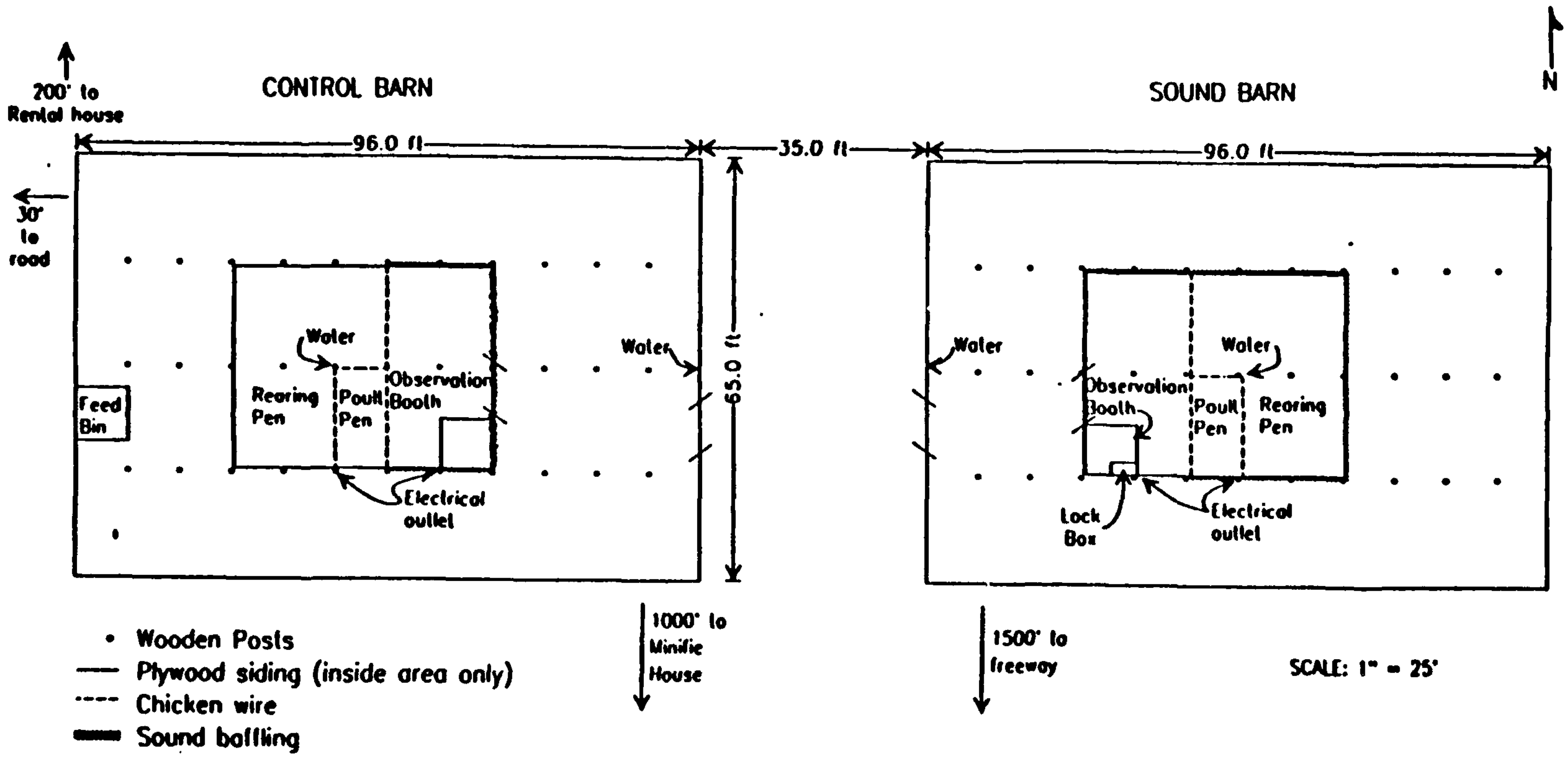


Figure 2-1. Setup for Experiments in Subtask 1.

loudspeaker for the system was attached to the center support beam of the barn facing downward into the turkey pens at a height of 17 feet. A Geirr 1400 time-lapse video system with a black and white camera was installed above the pen to monitor turkey behaviors. A noise map for this setup is given in Figure 2-2 showing the noise contours within the barn for the loudest stimulus (an F-4D overflight at 115 dB, see Table A-2 in Appendix A). Appendix A lists the sound levels represented by the areas contained within the contours for all the stimuli used in Experiments 1 and 3.

On the tenth day, the treatment birds were exposed nine times to simulated F-4 overflights at random intervals (intervals ranged from 10 tc 60 minutes) at 75 dB sound level with a 25 dB per second onset rate. Stimuli began at 0825 hrs and ended at 1240 hrs. Exposures on days 11 and 12 used the same stimulus but a different interval schedule within the experimental time frame. The schedule of exposures is given in Table 2-1.

The methods for these initial exposures require some explanation. From previous studies of habituation in laboratory animals (Hoffman and Searle, 1968), it is known that naive animals respond differently from animals that have habituated to some degree to the same stimulus. Responses decrease rapidly with repeated exposure after the first few presentations. In order to create a dose-response relation for naive animals, new individuals would have to be exposed at each experiment. After the initial rapid habituation, another dose-response relation determines their responses. Unfortunately, neither the initial "naive" dose-response relation nor one for relatively experienced birds has been described in any detail. We thus determined to measure the simpler of the two relations, or that applying to habituated birds. Although naive birds would respond more strongly, the form of the relation would be similar. Thus, it would be possible to predict which sound levels would be most disturbing based on the relation for habituated birds.

This rationale makes important presumptions: a) that habituation does not continue at a rapid rate after the first few exposures, and b) that behavioral responses such as crowding and alerting change in some predictable way with sound level. Based on studies of laboratory rodents, these presumptions are reasonable first approximations (Hoffman and Searle, 1968).

Six birds in each barn were marked with dye for behavioral observations. Any instances of crowding or piling were recorded as well as latency to first preen and cohesion (or comfort) call, and

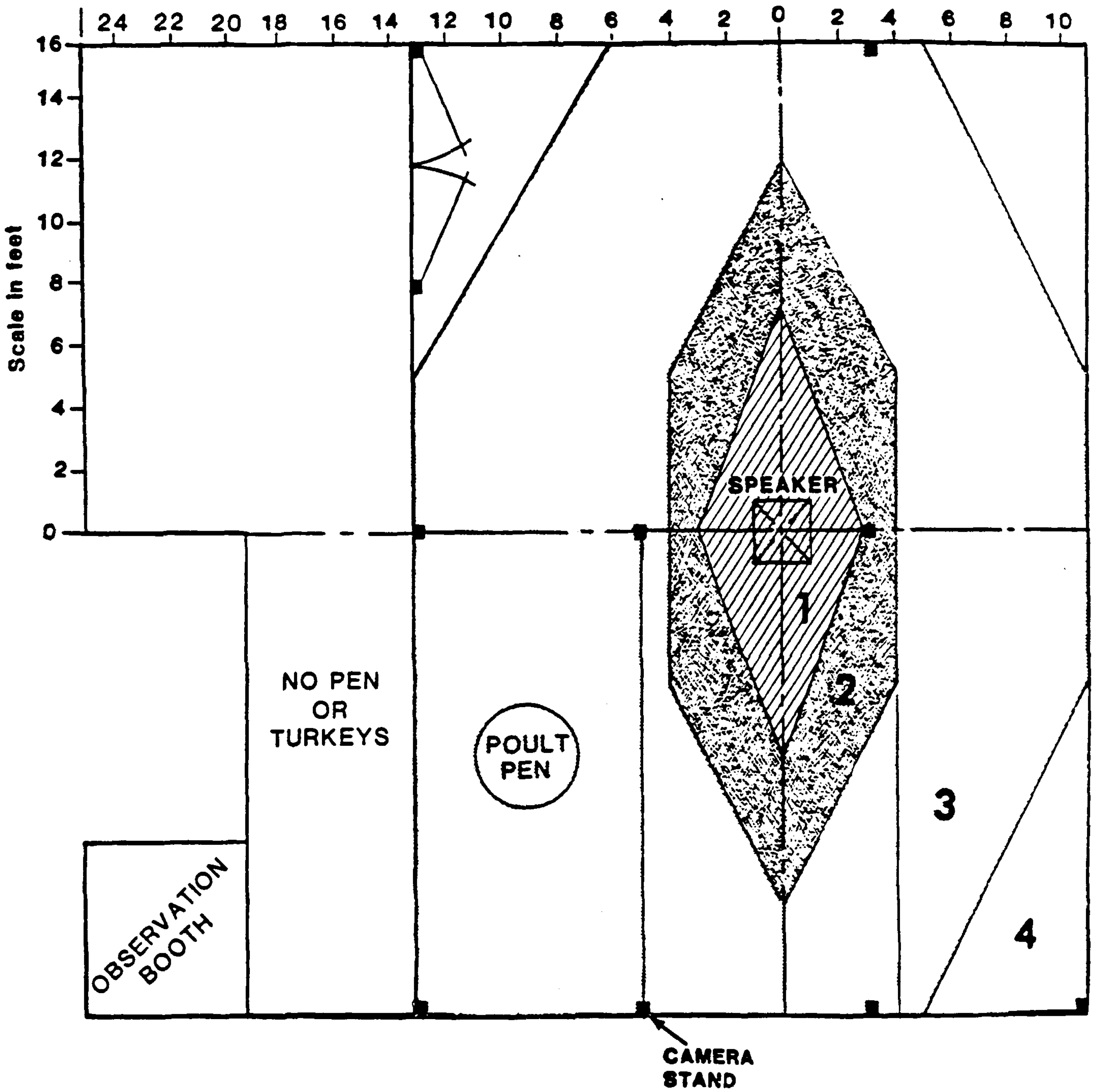


Figure 2-2. Noise Map of Sound Barn during Experiment 1.

Table 2-1. Schedule of Exposures Administered to Turkeys in Experiment 1 During the First Three Days.

Exposures 3/18/90		Exposures 3/19/90		Exposures 3/20/90	
Time	Interval (min)	Time	Interval (min)	Time	Interval (min)
0827	-	0725	1123	0700	1180
0837	10	0815	50	0735	35
0859	22	0825	10	0815	40
0942	43	0852	27	0845	30
0957	15	0905	13	0935	50
1027	30	0935	30	1025	50
1128	61	1020	45	1040	15
1207	40	1040	20	1050	10
1242	35	1120	40	1120	30

distances from each marked bird to its nearest neighbor, in animal lengths, were also recorded (focal animal lengths.) Videotape recordings of each exposure were sent to Hubbs for independent analysis.

After three days of exposure to the low-amplitude stimulus, the birds were not exposed to any aircraft noise for three days (see Table 2-2), after which they were exposed again. Videotape recordings continued and behavioral observations of group cohesiveness (percentage within one body length of another bird) were measured on the second day of rest.

After three days of rest (at 16 days of age), the poults were exposed to nine stimuli per day for three days. The simulated overflights presented on these days were F-4D overflights presented at random intervals in five different sound level and onset time combinations. These combinations are marked with an asterisk in Table 2-3. The same measurements were recorded as before. These exposures were intended to tease apart the roles of onset rate and sound level in determining responses.

On day 19, the birds were given to the ranch owner and new birds were brought in for the next subtask (Experiment 3).

2.2 Experiment 2: Comparison of Effectiveness of Noise Simulations Versus Actual Aircraft Overflights

The tests with actual overflights were designed to show whether simulated and actual aircraft overflights have similar effects on turkey behavior. In particular, there has been some concern that actual overflights arouse stronger responses as a result of combined visual and auditory cues. The role of the visual stimulus is not critical in studies of domestic birds, as it is standard practice to hold turkeys in closed barns now, but other aspects of the stimulus could enhance responses, particularly the binaural perception of a moving target (the simulator presents a static target), and the perceptual location (which is constant from the simulator).

A short pilot experiment was conducted to determine whether the results of the simulator study could be generalized to actual overflights without concern for these differences. These experiments were conducted in the Mojave Desert from 31 March to 6 April 1990 at Checkpoint C

Table 2-2. Schedule of Exposures Administered to Turkeys During the Second Three Days of Experiments.

Exposures 3/24/90			Exposures 3/25/90			Exposures 3/26/90		
Time	Interval	Stimulus	Time	Interval	Stimulus	Time	Interval	Stimulus
0716	-	36	0740	1240	20	0700	1158	06
0727	11	20	0827	47	34	0735	35	38
0747	20	34	0852	25	06	0815	40	34
0830	43	06	0902	10	38	0847	32	36
0847	17	38	0917	15	36	0937	50	06
0917	30	06	0947	30	20	1027	50	34
1017	60	20	1032	45	34	1042	65	36
1057	40	34	1052	20	38	1052	10	34
1132	35	38	1142	50	36	1122	30	20

Table 2-3. A List of the Stimuli Used in Experiments 1 and 3 by Stimulus Number. Acoustic characteristics of each stimulus are listed.

Aircraft Overflight						Aircraft Overflight Noise Descriptors					
						"A" weighted			"C" weighted		
ID#	Type	Alt (ft)	Dist (ft)	Speed (kts)	Onset ((dB/sec)	L_{eq}	MAX	SEL	L_{eq}	MAX	SEL
4	B-1B	546	59	575	27.0	102.0	114.8	112.8	102.0	116.5	115.3
6*	F-4D	1527	36	561	20.1	101.4	114.9	116.8	102.3	115.5	118.9
8	F-4D	449	36	560	54.7	101.6	114.8	113.4	99.1	114.7	114.6
10	F-4D	514	55	592	45.6	103.3	114.1	113.8	99.7	114.8	115.1
12	F-4D	114	5	597	107.7	104.1	115.0	110.8	100.5	115.0	112.0
14	KC-135	153	43	242	25.4	103.7	115.5	113.2	96.3	113.8	112.2
16	B-1B	414	272	582	33.3	102.6	114.4	113.0	99.5	115.6	115.3
20*	F-4D	1527		561	20.1		100.0	101.7		100.5	103.8
34*	F-4D	1527		561	20.1		85.0	86.7		85.6	89.6
36*	F-4D	449		560	54.7		84.9	83.6		84.8	85.0
38*	F-4D	514		592	45.6		84.4	83.8		84.8	85.5

(34° 55" N, 116° 11" W; see Figure 2-3), a turning point along several of the major low-altitude routes in the area (IR-212, IR-213, VR-1217). Twenty-four 7-week-old turkey poults were obtained from the same grower that provided turkeys for Experiments 1 and 3. None had been exposed to low-altitude jet overflights prior to the experiments, although they had been exposed to human disturbance of other sorts in the normal course of rearing (traffic, milking machines, light aircraft, etc.).

The poults were transported overnight from the growing farm near UCD to reduce the stress of transport, and were housed in two 2 x 6 m covered chicken wire pens at the experimental site (see Figure 2-4). Originally, they were to have been acclimatized to their new surroundings for a weekend before the first disturbance, to allow them to recover from the disturbances due to transport. However, an unseasonal series of thunderstorms struck the area unexpectedly (31 March through 1 April), disturbing the turkeys considerably. Thus, although they were not exposed to aircraft for over 36 hours after arrival, both the transport and the thunderstorms forced them to adjust to disturbance to some extent.

These initial disturbances probably altered turkey responses to the aircraft. The turkeys were held in much smaller groups than is normal in commercial practice, which was likely to alter their behavior as well. The purpose of these tests in the desert was not to determine whether actual aircraft are more *dangerous* to turkeys than simulated aircraft, but rather 1) to determine whether responses to actual aircraft were markedly different from those to simulations, and 2) whether this difference was explained by the visual component of the stimulus.

Because of the thunderstorms, the experimental pens were not set up fully until the morning of 2 April (see Figure 2-4). One of the pens was left with a clear view in all directions except for a small piece of cloth (1 m^2) that provided shade during the hot part of the day (temperatures ranged from 10-45° C; see Figure 2-5), and the other was covered almost completely with an acoustically-transparent black covering. One side of the covered pen (the one facing away from the direction of aircraft travel) was left open so the birds could be videotaped. Both pens were monitored with separate video recorders. An observer was present sitting quietly 5 m from the pens during the daylight hours; the video recorders were run for as much of this period as possible, battery supply permitting.

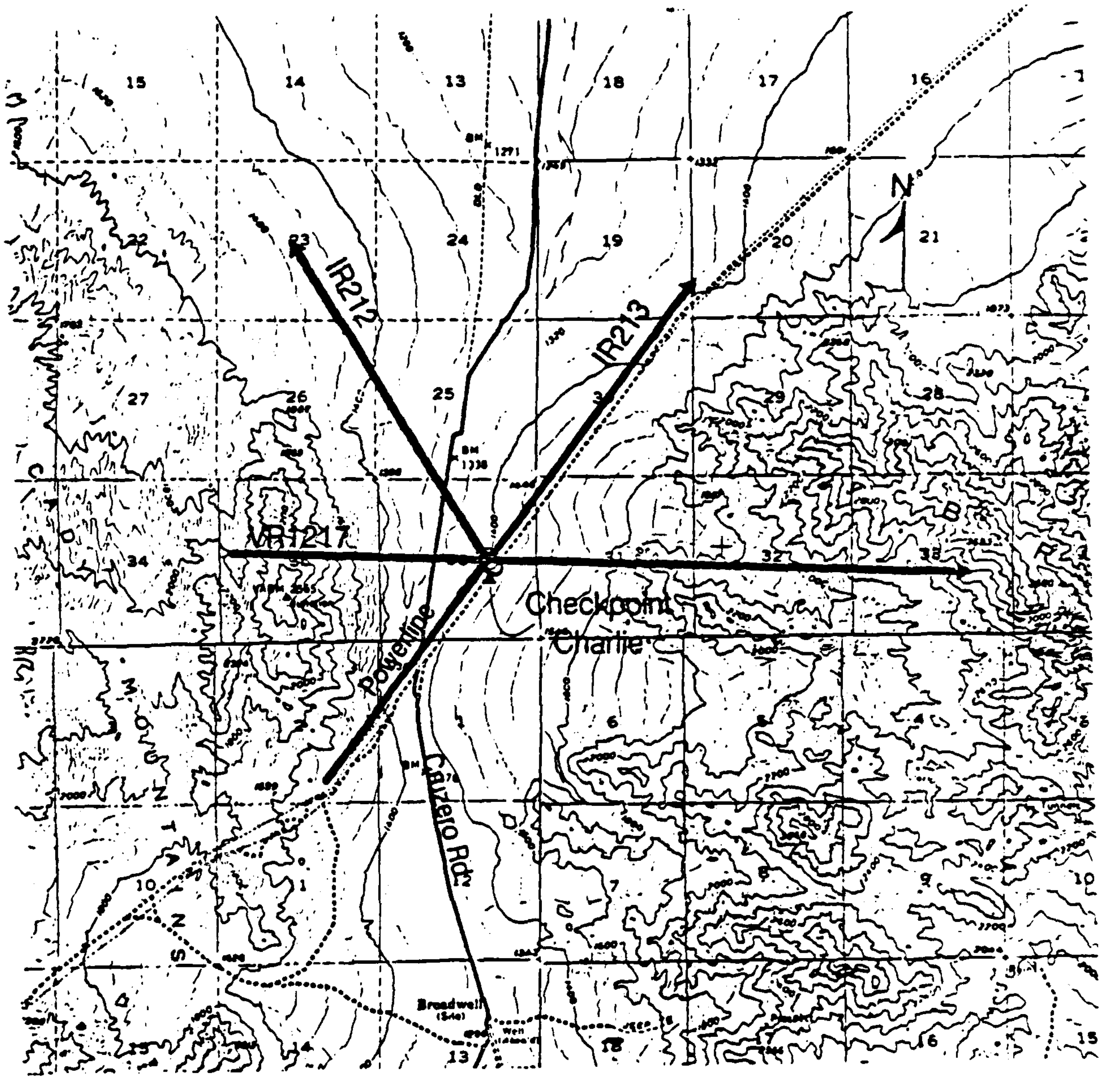


Figure 2-3. Map of Checkpoint C in the Mojave Desert Along IR 212, IR 213, and VR 1217.

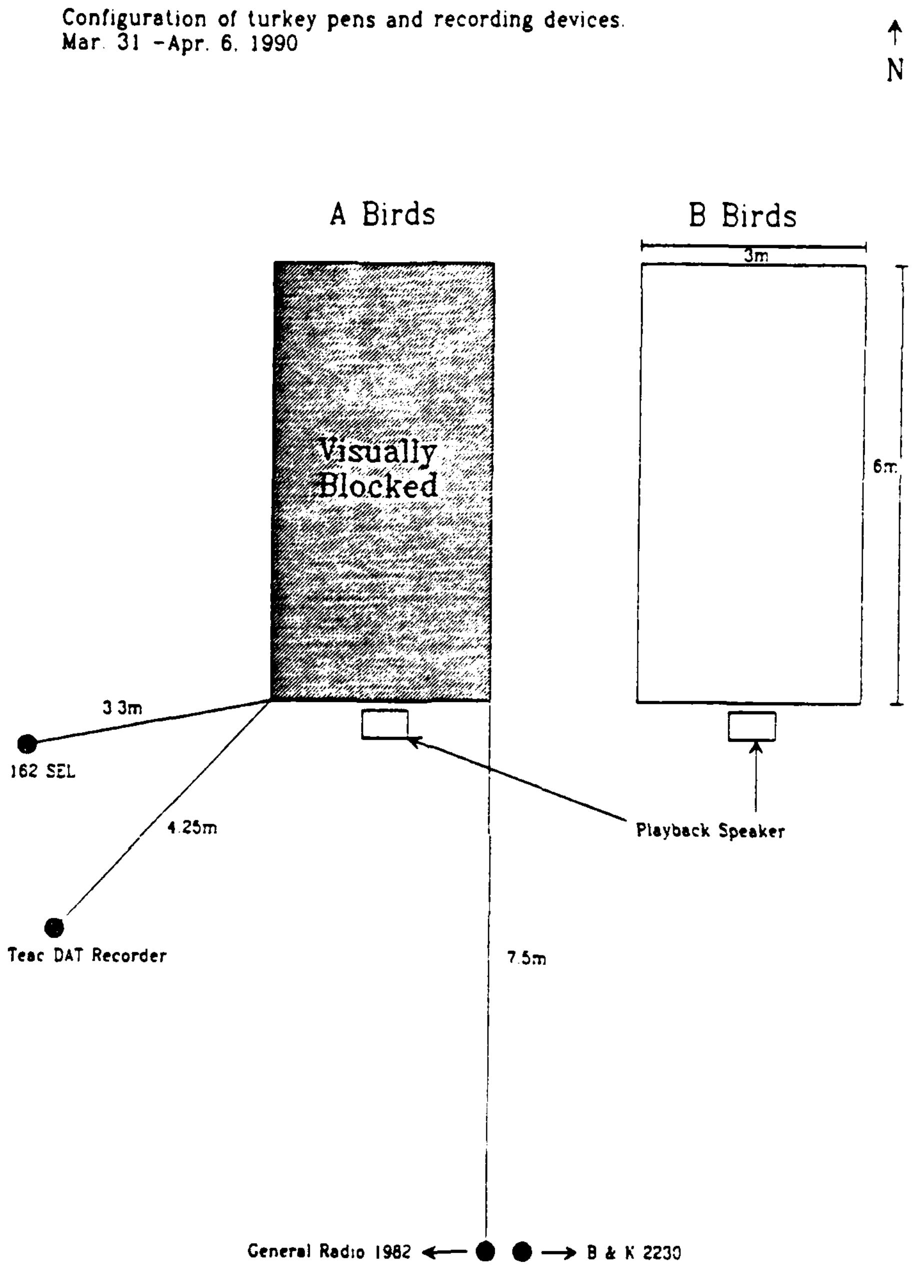


Figure 2-4. Setup of Pens, Sound Monitoring and Sound Playback Equipment for Subtask 2.

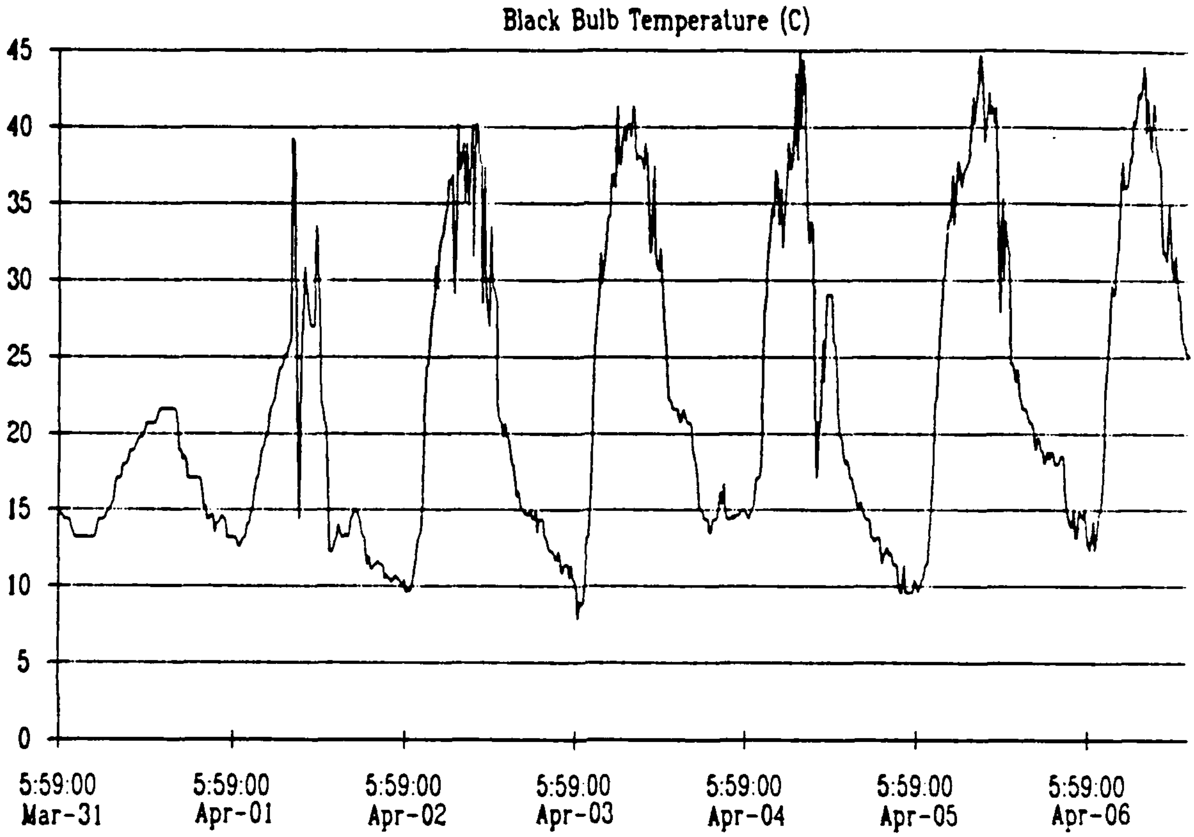


Figure 2-5. A Temperature Profile at Checkpoint C for 31 March Through 6 April (degrees in Centigrade units).

Noise from the aircraft was measured in several ways:

1) A TEAC RD101T DAT recorder and a B&K Type 4140 condenser microphone equipped with a 6 inch wind screen were used to collect as many of the overflights as possible. The data were processed in the laboratory at Hubbs on a Spectral Dynamics SD380 Signal Analyzer.

2) Sound levels, A-weighted sound exposure levels (SEL) and average 24 hour levels were measured with a CEL 162 SEL community noise monitor, and through a B&K 4140 microphone.

3) Sound levels and A-weighted sound exposure levels were also collected at the scene with a B&K 2230 Integrating Sound Level Meter, and C-weighted peak levels were collected with a GR 1982 sound level meter.

Aircraft sorties were photographed at their point of closest approach, for later determination of slant distance, with a Cannon A2 with a 200 mm lens. These photographs were taken on TriX 400 ASA black and white film to obtain sharp photographs for identification purposes. The distances measured from the photographs were intended as a check for visual estimates, which were made relative to a 120 ft power line that ran over the experimental site. The formula used to calculate distances from the photographs is given in Table 2.4.

The pens were also equipped with two overhead Polk Audio 4A speakers powered by an NAD 420 amplifier for playback experiments. These speakers produced a maximum A-weighted sound pressure level of 102 dB at the center of each pen at turkey head-height, with response ranging from .01-15 kHz. The system did not have the same low-frequency response or power as the BBN sound simulation system installed at UCD, but this system would have been prohibitively difficult to install in the field for such a short-term project. The field system did provide means to conduct some preliminary experiments on responses to simulated sound versus actual overflights. The field system was powered by a small Yamaha 600-watt generator kept at 100 m from the study site.

Table 2-4. Formula Used to Estimate Aircraft Distances from Photographs.

FORMULA H
Determining subject distance

SYMBOLS	DEFINITIONS	EXAMPLES	
F	Lens focal length	12"	(304.8 mm)
h	Subject size	15"	(381 mm)
h'	Image size	.5"	(12.7 mm)
v	Lens-to-subject distance	? (unknown, to be determined)	

Formula

$$v = \frac{F \times h}{h'}$$

$$v = \frac{12 \times 15}{.5}$$

$$v = 360'', \text{ or } 30' \left(\frac{304.8 \times 381}{12.7} = 9144 \text{ mm, or } 9.14 \text{ meters}\right)$$

In all, the turkeys were exposed to 33 low-level (below 1,000 m) overflights of aircraft from various agencies from 2-6 April (roughly 6 flights per day). Twenty-one of these were from fighter aircraft at or below 300 m (4 per day). A typical amplitude profile for one of these overflights is given in Figure 2-6. Peak sound levels of the fighter overflights ranged from 79 to 114 dB. The lowest jet overflight was estimated at 70 m (the floor for the route is 67 m, or 200 ft). Based on their markings, the fighters belonged to the U.S. Navy, the U.S. Marines, and the USAF. We identified them as F-4, F-18, A-4, and A-6 fighters based on photographs taken during the study (identifications were confirmed by Air Force experts). The other aircraft were large C-130 transports, Bronco OV-10 surveillance aircraft and two small commercial utility helicopters belonging to the California Highway Patrol and the Line Patrol for Southern California Edison. We also experienced overflights by large commercial jetliners at around 30,000 ft 5-10 times per hour during the daylight hours. Although the jetliner overflights were not likely to arouse significant responses, the turkeys in both pens did orient on them. The turkeys in the open pen could see them and often spotted them before observers did. A list of the overflights is given in Table 2-5.

A list of the fighters scheduled to be in the area is given in Tables 2-6 and 2-7. Based on examination of these tables and Table 2-5, the correspondence between scheduled and observed overflights was reasonably good with a few exceptions. None of the three flights on 2 April was on the schedule. Moreover, none of the OV-10 and C-130 overflights was scheduled. Forty-three fighter sorties were scheduled, but only 23 were flown.

The turkeys were exposed to recordings of the actual overflights starting on 5 April. The sound levels, schedule, and stimulus type of the simulated overflights are given in Table 2-8. Actual overflights occasionally intermixed with the simulated overflights, although we tried to schedule the simulations to avoid the most intensive flight activity. These flights indicated how well the simulations had habituated the turkeys to overflights.

The simulations and as many overflights as possible were recorded on videotape. Five minute segments before and after each experiment and overflight were examined to determine what changes in behaviors occurred. Numbers of incidents of running and displacements were counted for each minute in the segments. Numbers of birds lying, walking, feeding, and preening were recorded in still-frame at 1-minute intervals (scan samples).

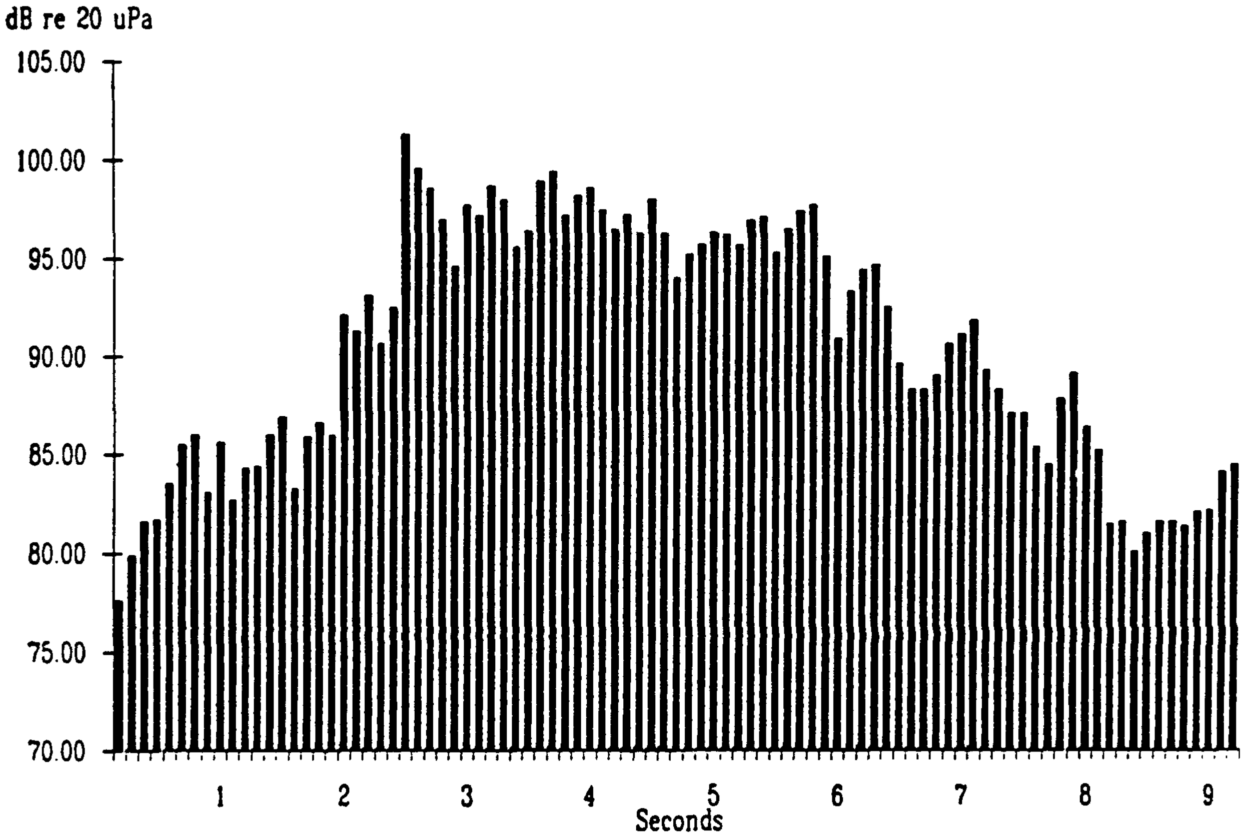


Figure 2-6. Typical Sound Level Profile of Overflights at Checkpoint C.

Table 2-5. Summary of Experiments Conducted during Experiment 2.

Day	Time	Flight	Distance (m)	Duration (sec)	Lmax (dB)	A-SEL (dB)	Aircraft	Pen A Call (sec)	Pen B Call (sec)	Pen A Preen (sec)	Pen B Preen (sec)
2	1043	1	>1000	20	-	-	2 F-4	-	-	-	-
2	1256	2	300	30	112.2	113.9	2 F-18	285	360	285	360
2	1440	3	200	20	96.2	99.7	2 F-4	90	60	90	60
3	0835	4	150	25	104.5	109.4	4 F-4	25	55	20	55
3	1322	5	450	30	100.5	102.5	1 F-18	-	-	-	-
3	1426	6	90	20	98.2	100.5	A-6	24	30	40	40
3	1436	7	2000	15	< 75.0	-	F-4	-	-	-	-
3	1549	8	2000	15	-	-	2 F-18	-	-	-	-
4	1050	9	500	20	86.1	79.8	2 A-4	-	14	-	14
4	1132	10	80	60	113.4	115.8	3 F-4	82	57	44	60
4	1735	11	1000	20	< 75.0	-	C-130	25	45	-	-
4	1813	12	300	15	80.3	80.6	A-6	30	-	-	-
4	1857	13	1500	30	< 75.0	-	F-18	43	25	-	-
5	0843	14	100	20	91.0	96.5	2 F-18	16	22	35	-
5	0943	15	350	20	< 75.0	-	2 OV-10	36	25	36	73
5	1010	16	2500	15	< 75.0	-	F-18(?)	25	7	23	33
5	1101	17	1200	60	< 75.0	-	C-130	58	0	58	50
5	1150	18	100	60	103.2	108.1	4 F-4	-	-	-	-
5	1411	19	100	30	92.4	95.6	2 A-4	40	42	46	-
5	1437	20	2000	20	85.4	86.3	2 A-4	-	-	-	-
5	1510	21	2000	30	< 75.0	-	C-130	16	11	67	30
5	1637	22	1000	60	-	-	2 A-4	69	57	76	66
5	1727	23	1000	20	76.7	79.5	A-6	34	32	-	-
6	0834	24	150	35	103.7	107.9	2 F-4	41	44	33	37
6	0855	25	700	30	98.3	102.0	2 F-18	-	20	-	37
6	1032	26	150	60	107.0	112.4	3 F-4	18	67	34	73
6	1040	27	300	20	85.2	87.7	2 A-4	10	4	15	33
6	1356	28	300	40	-	-	2 OV-10	27	34	-	35
6	1402	29	100	120	81.3	76.7	Helo	58	183	83	-
6	1406	30	100	60	82.2	88.2	Helo	5	30	42	35
6	1410	31	550	60	82.4	83.5	2 OV-10	-	56	-	77
6	1421	32	2000	30	-	-	C-130	-	29	-	32

Table 2-6. Flights Scheduled for VR 1217 by George Air Force Base during 31 March - 6 April.

Date	Times (Entry/Exit)	#/ Type Aircraft
31 Mar	None	None
1 Apr	None	None
2 Apr	1655-1710	4 F4
	2055-2110	4 F4
	2215-2230	2 F4
	1605-1615	2 F4
3 Apr	1515-1525	4 F4
	1945-1955	3 F4
4 Apr	1515-1525	2 F4
	1825-1840	4 F4
	1945-1955	2 F4
	1955-2010	2 F4
	2115-2125	3 F4
	2225-2240	2 F4
	2325-2335	2 F4
5 Apr	1445-1455	4 F4
	1515-1525	2 F4
	1845-1855	4 F4
	1915-1925	2 F4
	1945-2000	4 F4
6 Apr	1445-1455	2 F4
	1530-1545	2 F4
	1725-1740	4 F4
	1915-1925	2 F4

Table 2-7. Flights Scheduled for VR 1217, IR 212, and IR 213 by El Toro Air Force Base during 31 March - 6 April.

Route	Date	Time	Type of Aircraft
IR 212	No Flights		
IR 213	3	14:15-15:15	F-4
IR 213	3	15:45-16:30	F-18
IR 213	3	12:20-13:20	F-14
IR 213	4	14:45-15:45	F-18
IR 213	5	13:45-14:45	F-18
IR 213	5	7:45-8:45	F-18
IR 213	5	14:30-15:30	A-6
IR 213	6	15:15-16:15	F-18
VR 1217	3	13:30-14:30	F-18
VR 1217	4	13:30-14:30	F-18
VR 1217	4	14:30-15:30	A-6
VR 1217	4	9:30-10:30	F-14
VR 1217	4	15:30-16:30	A-6
VR 1217	4	8:15-9:15	A-4
VR 1217	4	15:00-16:00	A-4
VR 1217	5	17:30-18:30	A-6
VR 1217	5	21:00-22:00	A-6
VR 1217	5	9:30-10:30	F-14
VR 1217	5	16:30-17:30	A-4
VR 1217	6	10:30-11:30	A-4
VR 1217	6	16:30-17:30	A-4
VR 1217	6	14:30-15:30	A-6
VR 1265	5	20:00	AV-8
VR 1265	5	16:30	A-4

Table 2-8. Summary of Simulation Playbacks Conducted during Experiment 2.

Day	Time	Interval (min)	Experiment	Duration (sec)	Pen A Lmax (dB)	Pen B Lmax (dB)	Pen A Call (sec)	Pen B Call (sec)	Pen A Preen (sec)	Pen B Preen (sec)
5	0930	-	1	30	80.5	81.7	40	50	57	60
5	0955	25	2	30	80.5	81.7	33	21	33	21
5	1000	5	3	30	80.5	81.7	33	40	52	61
5	1010	10	4	30	80.5	81.7	53	45	52	108
5	1040	30	5	30	80.5	81.7	05	36	22	28
5	1055	15	6	30	80.5	81.7	26	58	17	33
5	1715	380	7	30	77.7	83.3	10	26	42	37
5	1725	10	8	30	77.7	83.3	09	16	20	22
5	1740	15	9	60	94.7	94.9	66	68	87	74
5	1745	5	10	60	94.7	94.9	62	62	75	73
5	1818	33	11	60	94.7	94.9	56	75	70	65
5	1827	10	12	60	94.7	94.9	56	65	65	65
5	1840	20	13	60	94.7	94.9	62	62	-	-
6	0830	830	14	30	77.7	83.3	0	27	27	27
6	0835	5	15	30	77.7	83.3	0	28	0	0
6	0840	5	16	30	77.7	83.3	3	38	0	0
6	0850	10	17	60	94.7	94.9	14	27	20	30
6	0915	25	18	60	94.7	94.9	33	52	15	42
6	0920	5	19	60	94.7	94.9	16	48	12	38
6	0935	15	20	60	94.7	94.9	30	35	76	70
6	0955	20	21	60	94.7	94.9	28	68	64	16
6	1615	380	22	30	77.6	78.0	15	14	20	20
6	1620	5	23	30	77.6	78.0	0	0	0	0
6	1625	5	24	30	77.6	78.0	0	36	0	4
6	1645	20	25	45	96.7	96.1	20	69	52	63
6	1655	10	26	45	96.7	96.1	10	42	50	55
6	1705	10	27	45	96.7	96.1	40	-	35	42
6	1730	25	28	45	96.7	96.1	58	-	48	19
6	1740	10	29	75	99.0	102.3	93	133	36	43
6	1755	15	30	75	98.0	98.0	50	50	-	-

In addition to these general characterizations, we also recorded the responses to the overflights or simulations. While in the field, we measured time to first preening and time to first cohesion call for comparison with the results of the UCD experiments. From the videotapes, we measured the number of birds that stopped their activities to alert, the time to return to activity, the number that ran or fluttered in response, and the number that gaped in response to the overflights.

2.3 Experiment 3: Determining Effects of Aircraft Noise on Behaviors, Growth, and Carcass Quality of Naive Turkey Poults

2.3.1 Sound exposures and video monitoring used in Experiment 3

The experimental barn was equipped with the same sound simulation system described under Experiment 1 methods above. The turkeys in Experiment 3 were naive at the start of exposures. They were exposed to the estimated worst-case (i.e., most disturbing) aircraft stimuli 18 times per week (4-6 exposures, 4 days per week), an estimate of the worst possible case that would ever be found in actual practice near a commercial operation. Exposures occurred at random during the 14 hours of daylight on exposure days and handling was the same throughout the week, so that turkeys could not predict when exposures might occur.

The exposure stimuli all had sound levels of over 100 dB at ground level directly under the speaker (see Figure 2-7). The exact stimuli used and a schedule of exposures are given in Appendix B. The turkeys were observed by researchers at all exposures for the first two days of the experiment, and every fourth exposure thereafter. In all, the turkeys were exposed to 170 simulated overflights from 29 March to 4 June.

The turkeys in the large pens in both the control and the experimental barns were monitored with the time-lapse video system throughout Experiment 3. The camera was mounted over the pens with a clear view of the feeding stations, the area immediately under the speaker, and most of the 100 poult pen. The areas that could not be covered in the field of view were those along the fence-line adjoining enclosures and directly under the camera mount. Unfortunately, although the turkeys occupied visible areas in Experiment 1, they often rested in invisible areas, near the birds in other pens but out of view of the camera in Experiment 3. Most active turkeys were visible within the field

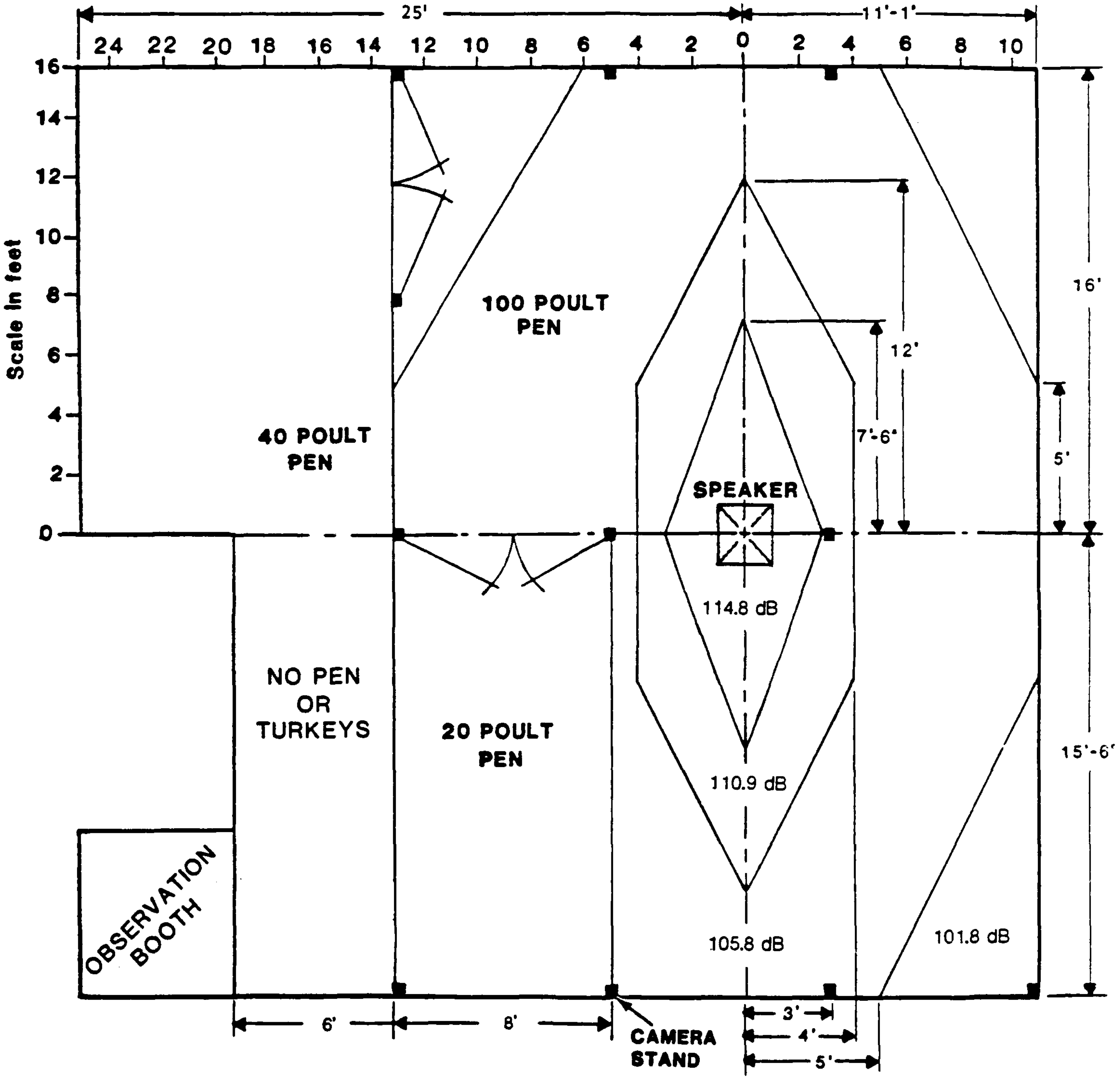


Figure 2-7. Noise Map for the Pens in Experiment 3. Levels Are Average A-Weighted Sound Exposure Levels.

of view. In the early stages of rearing, the turkey poults were kept under warming lamps. Glare from these warming lights often made it difficult to make counts of feeding and resting birds, but repeated counts were consistent to within a few birds, so relative comparisons of bird activity could be made. The lights were turned off after the middle of April and visibility improved substantially.

2.3.2 Rearing conditions and measurements on live turkey poults

On 28 March, 6-week-old hen poults were introduced into the control and experimental barns. There were three floor pens per barn, and the birds were placed in groups of 20, 40, and 100. They were brooded under standard conditions at a separate location prior to introduction. All turkeys were transported at the same time and were selected for control and experimental groups at random. The birds were maintained on a 14L:10D lighting schedule optimal for growth.

Wood shavings 2-4 inches deep were used as litter in the pens. Each pen was outfitted with Plasson poultry waterers. The large pens in each barn each had two waterers and two feeders. The small and medium pens in each barn contained a single waterer and feeder. Poults were started on feed troughs and then switched to Little Giant hanging feeders. Feed and water were provided *ad libitum* except for a period of approximately 14 hours prior to slaughter. The poults were started on a 28% poult starter ration and gradually switched to a 24% turkey grower ration beginning at 25 days of age. The switch was done as follows: a) day 1 - 75% starter, 25% grower, b) day 3 - 50% starter, 50% grower, c) day 5 - 25% starter, 75% grower, and d) day 7 - 100% grower. Feed formulations are shown in Appendix C. Feed consumption was calculated on a per-pen basis. Feed weights were measured before and after feeding to estimate consumption. The grower ration was a commercial diet available in small quantities.

A subsample of birds in each barn was weighed weekly throughout the growing period (6 weeks to 17 weeks of age). The first weights were obtained on 28 March. At that time, 40 birds were weighed from each of the large pens, 20 each from the medium sized pens, and 10 each from the small pens. The birds in each pen were randomly selected and identified with color codes (first by painting their shanks, later with colored leg bands). The same birds were weighed once a week throughout the experimental period. When a bird lost its band, another bird was randomly selected and weighed. The birds were weighed for the final time on 4 June. This date was two days earlier

than the normal weekly weighing date, but was chosen in order to accommodate the processing plant schedule.

2.3.3 Health maintenance and processing

Bird health was monitored by the consulting veterinarian, Dr. Kim Joyner. Birds that failed to thrive at all were removed, killed, and posted by Dr. Joyner. Blood and tissue samples, as necessary, were sent to the California Veterinary Diagnostic Laboratory (CVDLS) at UCD. Dr. Joyner consulted with the CVDLS pathologist on all submissions. With the removal of a bird from one barn, a comparably-sized bird in the opposing barn was removed, thus keeping the density balanced. Due to the isolated location of the commercial poultry ranch, it was not necessary to vaccinate the turkeys against common contagious diseases. The birds were beak trimmed twice during the experiments (11 April and 9 May) in an attempt to reduce picking activity. (Normally, they are trimmed only once, at the start of rearing.)

Late in the afternoon after the final weighing, feed was denied to all the birds. This is a standard practice and ensures a relatively empty gastrointestinal tract at the time of processing. Water was never removed from the birds. The birds were caught and loaded by a professional live haul crew at 0300 hrs on 5 June. Ten, twenty, and forty birds were selected from the small, medium, and large pens, respectively, in each barn. Half of the birds in each group were banded birds and the other half were unbanded (35 in each group). All birds received additional color leg codes that morning. This additional coding was done to insure that pen and barn identification were not lost in the hauling and slaughter processes.

The birds were transported in a commercial turkey live-haul truck from the research site to the New American Poultry Processing Plant in Sacramento (approximately one half hour away). Processing began at approximately 0830 hrs. Research staff were posted at key locations on the processing line to insure proper handling of the birds and to prevent loss of bird identification codes. A Federal Poultry Meat Inspector (PMI) was on the eviscerating line to insure that all the products met wholesomeness standards. In addition, the services of the Assistant to the Federal State Supervisor and the Poultry Grader who serves as Grader-in-Charge for the Con-Agra Foods Turkey Processing Plant in Turlock were obtained. The latter graded all the carcasses.

There are three official USDA Poultry Meat Grades: A, B, and C, with A being the highest grade. Birds that did not meet the requirements for any of the three grades were called "no grades." A "no grade" bird is still wholesome and can go through a further processing line. A summary of specifications for the various grades is given in Appendix D. The type of grading performed is known as a "hot grade" (the carcasses are graded immediately as they come off the eviscerating line and prior to going into the chill tank). This is the most rigorous type of grading. The other type of grading is known as a "cold grade" (the carcasses are graded after being in the chill tank). The chilling process bleaches out some fresh bruises that can cause birds to be downgraded.

2.3.4 Survey study

Nothing is known about rates of crowding and piling in commercial practice. To get an initial sampling of the experiences of turkey growers with crowding and piling, a short questionnaire was developed for distribution during a grower symposium, the California Turkey Forum. Dr. Francine Bradley developed the questionnaire, which was reviewed by a consumer science specialist, Dr. Christine Bruhn (University of California Cooperative Extension). The questionnaire does not constitute an epidemiological survey, as it was not administered to a random sample of farms.

An example of the questionnaire is given in Appendix E. It was designed to elicit information from growers on the incidence of stampeding/piling resulting in injuries or mortality, the environment in which the incident occurred, and the producer's ideas about the cause(s). It is specifically very vague in requesting information about causes in an effort to avoid biased responses to the questionnaire.

The questionnaire was delivered to growers on 9 May 1990, at the California Turkey Forum. the largest meeting of growers in the state of California. All responses were voluntary and were collected at the forum by an experienced Cooperative Extension Turkey Specialist (Mr. John Voris).

2.4 Experiment 4: Independent Analysis of Videotaped Behaviors of Turkey Poults Chronically Exposed to Worst-Case Aircraft Noise

Time-lapse video recordings were obtained of both the control and experimental pens for all days during Experiments 1 and 3 (18 March through 4 June). These video recordings were examined

by the UCD team to confirm behavioral observations made directly during the experiments, and were then submitted to Hubbs for independent analysis.

The videotapes were scored by research assistants with no previous experience with the project. A senior investigator (Bowles) trained the assistants to observe turkey behaviors, but they were not given the times of the experiments until after they had completed the first set of scorings on each tape. The purpose of this blind scoring was to obtain unbiased estimates of rates of agonistic and other behaviors prior to scoring the results of the experiments. The assistants scored a 15 minute segment around the time of the experiment. They counted numbers of birds running, numbers of "fights" (chest-pushing, attacks and picking were pooled into this category), and numbers of displacements each minute during this sample period (counts). In addition, they counted the number of birds feeding, preening, lying within view of the camera, and walking about the enclosure in at 1 minute intervals (scan samples). These data were used to compare behaviors immediately before and after exposure. Preening, threat ruffles, and picking proved difficult to score from the camera angle provided.

Once the tapes were scored, the assistants were given the exact times for each of the experiments. They estimated the number of birds visible that alerted in response to the exposure, the number that ran or jumped in response, the latency to the first return to normal activity, latency to last return to normal activity, and numbers of birds crowding or piling. Individual responses could not be measured readily, but notes of any unusual behavior were collected. In addition, they monitored the order of responses within the field of view to determine whether birds exposed to the highest sound levels were most likely to respond first. Later responses were likely to be stimulated by the initial responses, a flock effect.

Behaviors were also scored at three other times of day (0700 hrs, 1300 hrs, and 1800 hrs) to determine normal rates of behaviors. The three times provide a crude estimate of diurnal changes in activity.

2.5 Experiment 5: Analysis of Data for Inclusion in a Model for Aircraft Noise Effects on Turkeys

The results of Experiments 1, 2, and 3 were examined to determine the effects of noise parameters, stimulus duration, stimulus type, interval between exposures, and sequence on turkey responses. These data were then fitted to the hypothetical curves given in Bowles *et al.* (1990) and Reddingius and Bowles (1990). Because the turkeys remained naive for an unexpectedly short time (1-2 exposures), the relation between noise dosage and latency to recover from a response in naive birds had to be inferred from the habituated response curves and the published literature. The dose-response relation was determined for habituated birds based on latencies to recovery after a startle, both after actual overflights (data from Experiment 2) and to simulated overflights (Experiments 1, 2, 3).

3.0 RESULTS

3.1 Experiment 1: Determining the Stimuli Most Effective for Startling Naive Turkeys

The initial responses to low-level, slow-onset aircraft noise (85 dB at 25 dB per second) were not strong. The poults were not tested at less than 7 days of age because Von Rhein (1983) suggests that domestic chickens make the transition to running rather than crouching in response to loud sounds at around 6-7 days of age. Turkeys of the age tested (10-19 days of age) ran rather than crouched when humans entered the barns, so they had also reached the running stage at the time of the experiments. Although a few individuals ran or darted (jumped a short distance) after the initial exposure, no piling or crowding was observed in response. Aircraft noise with a sound level of 85 dB and onset rate of 25 dB appears to be under the threshold for the crowding response.

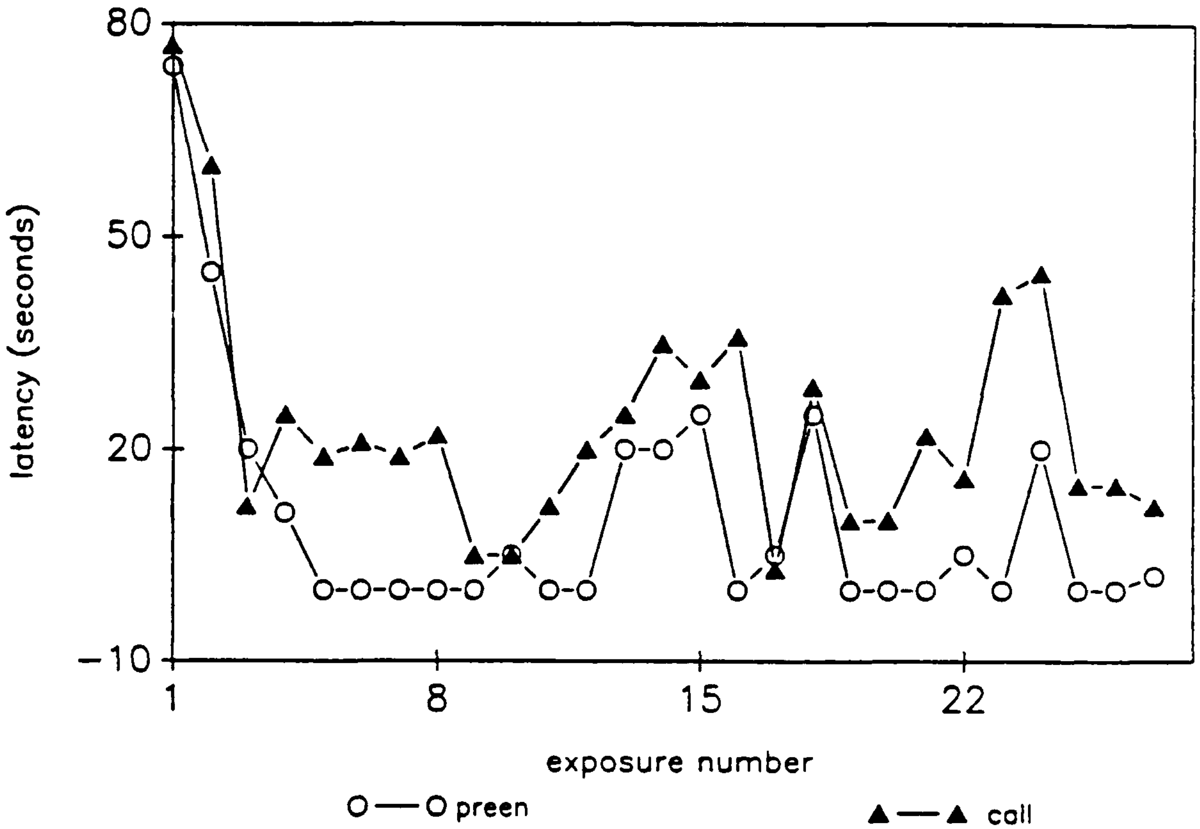
Crowding and piling did not occur to any of the initial series of stimuli. Thus, another measure of response had to be chosen. The standard measure of recovery from a surprise is latency between the response (in this case, alerting) and recovery (measured by preening and comfort calling). These measures were chosen based on standard textbook methods (Peeke & Herz, 1974), as systematic measures have not been used in studies of aircraft noise effects on poultry.

Latencies were analyzed using the general linear model Analysis of Variance (ANOVA) in SAS (SAS, Inc., 1985). Focal animal distances were analyzed using a repeated measures ANOVA.

Figure 3-1 shows the responses during the first three-day series of experiments, which exposed the birds repeatedly to the same stimulus. Latencies were greatest after the first exposure (150 sec), and never approached this value after the first 1-2 exposures. The initial exposure to a low-level stimulus reduced responses by 50% without regard to sound level or onset time. This very sharp decline in responsiveness shows the importance of habituation; without obtaining a fresh set of birds for each day's experiments, no useful dose-response relation can be developed for naive birds.

Based on the 27 exposures in the second 3-day series of experiments, latency to first preen and first comfort call were significantly elevated (ANOVA, $P<.001$ and $P<.002$ respectively) in response to the stimulus with the 25 dB per second onset rate and 115 dB maximum sound level (see

GRAPH OF LATENCY TO FIRST PREEN AND CALL DURING HABITUATION



Note: all sound exposures are 25 dB/sec, 85 dB max.

Figure 3-1. Response Latencies for the First Three-Day Sequence of Exposures in Subtask 1.

Figures 3-2 and 3-3). All other combinations were not significantly different from one another. This observation was somewhat counter to expectation, as onset rate plays an important role in determining the degree of startle in humans. The mean values and standard errors obtained in this analysis are given in the figures. The order of presentation is given in Table 2-2, showing that exposure to the next lowest level stimulus (100 dB at 25 dB per second) actually preceded the presentation to the 115 dB stimulus. Responses were much greater to the 115 dB stimulus even after 23 previous exposures.

Sound level appeared to explain the differences much better than onset rates. Figure 3-4 suggests another explanation for the difference between the responses to the 115 dB stimulus and to the others. The 115 dB stimulus also had the longest duration. Thus, sound exposure level should be considered the most important predictor of response for future experiments.

Measures of animal cohesiveness (focal animal distance) were not significantly different for any stimulus type ($P<.675$ two minutes prior, $P<.534$ during overflight and $P<.654$ two minutes after overflight). No panic piling was observed, even after exposure to the most effective stimulus. Either the initial habituation, even if to low-level exposures, was sufficient to extinguish the panic response, or the turkeys were not prone to piling.

3.2 Experiment 2: Comparison of Effectiveness of Noise Simulations Versus Actual Aircraft Overflights

3.2.1 Responses to aircraft overflights

The turkeys were exposed to several days of storms, including severe winds, thunder, and lightning prior to their first aircraft exposure. At no time during the initial transport, exposure to the storm, exposure to aircraft, or final transport did the turkeys stampede dangerously or pile. They did panic (flying around and bashing themselves against the fencing) and crowd in response to handlers entering the enclosure and to a kit fox (a predator) that investigated their enclosure the first two nights of the experiments. None was injured.

GRAPH OF LATENCY TO FIRST CALL DURING SOUND DIFFERENTIATION

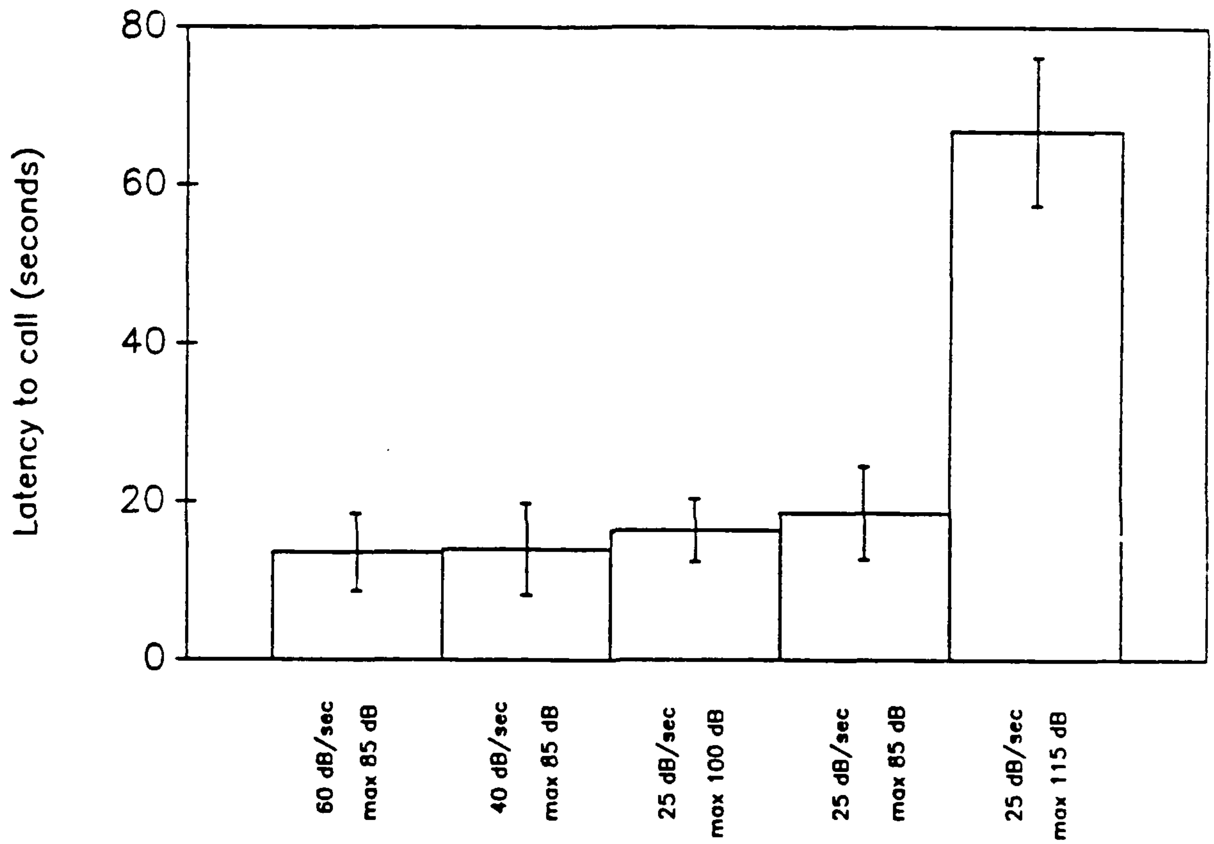


Figure 3-2. Comparison of Mean Latencies to First Cohesion Call for All Stimulus Types in the Second Series of Experiments in Subtask 1. Stimuli were presented in random order (see Table 2-2).

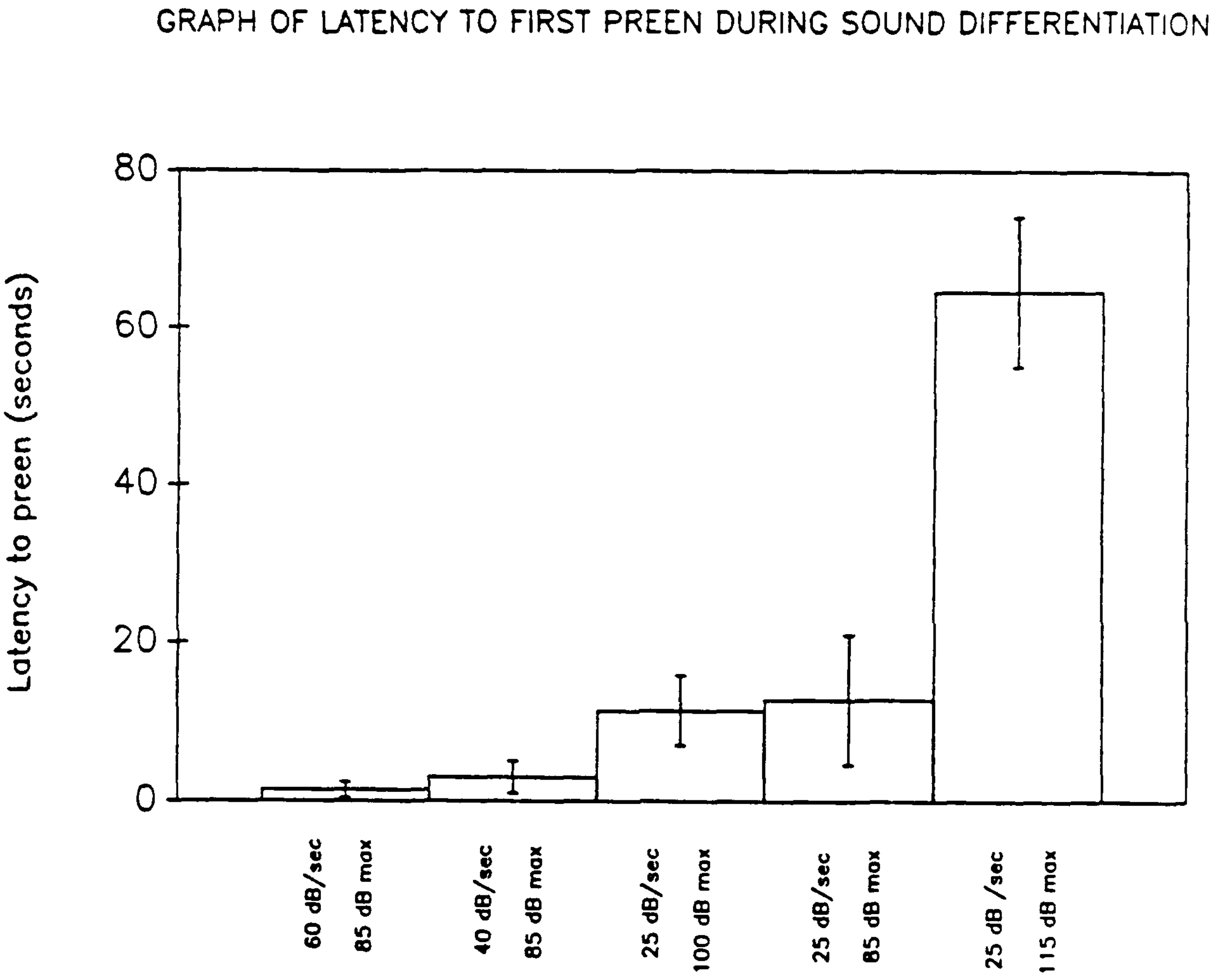


Figure 3-3. Comparison of Mean Latencies to First Preen for All Stimulus Types in the Second Series of Experiments in Subtask 1. Stimuli were presented in random order (see Table 2-2).

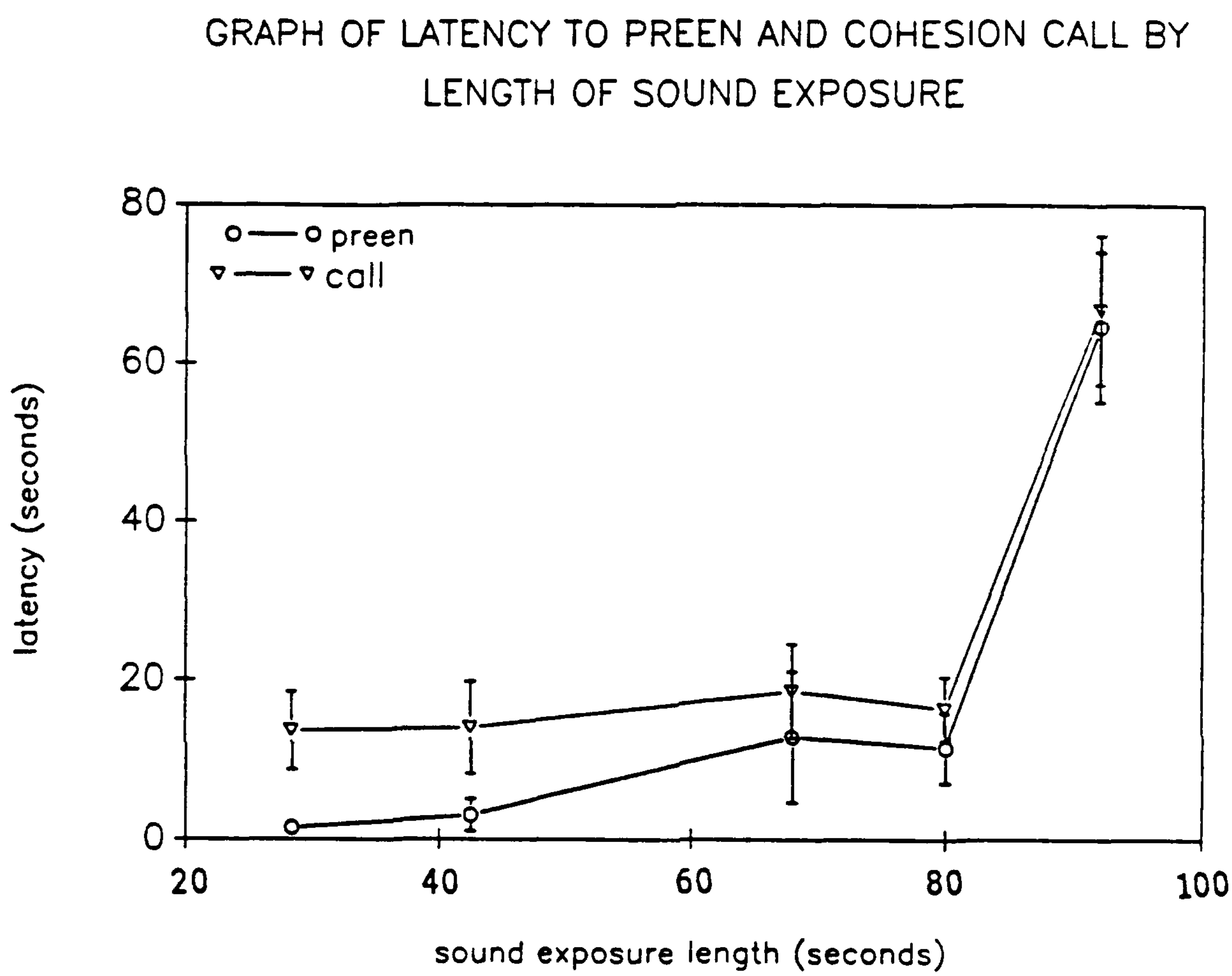


Figure 3-4. Relation Between Response Latencies and the Duration of Simulated Overflights. The longest stimulus also had the highest sound level.

Because winds associated with the storm tore down the enclosures several times during 1 April and early on 2 April, the turkeys were not entirely settled at the time of their first exposure to aircraft. The first jet that travelled over the area was very distant and aroused few alerts, presumably due to masking from wind noise. The turkeys were in one pen and were being whipped by high winds. Their responses were videotaped, and it is clear from the video footage that the turkeys were already disturbed due to wind and probably did not detect the aircraft.

The second exposure occurred when the camp was being rebuilt, after the winds had quieted. It was among the loudest recorded during Experiment 2. Two F-4 aircraft flew along the power lines, passed over the experimental site at an altitude of around 100 m, turned along IR 213, and disappeared. The CEL 162 monitor measured a sound level of over 113 dB. The GR1982 obtained a peak flat sound pressure level of over 130 dB when one aircraft turned on its afterburners in the direction of the camp. The turkeys responded to this event by stopping their activity, orienting on the aircraft and standing perfectly still until the sound of the aircraft had faded completely and for nearly a minute after the planes had gone. They did not begin to preen or give cohesion calls for over 3 minutes, although some relaxed prior to that. Unfortunately, the video was not on at the time due to the reconstruction underway.

The sequence of behaviors after this initial exposure was typical of responses throughout the rest of the week. Some of the turkeys stopped what they were doing, oriented on the aircraft (even when they could not see it), stood perfectly still for a time, then returned to normal activities, such as eating. They were quieter for 3-5 minutes after the aircraft had passed, relative to the 3-5 minutes prior.

Table 2-5 summarizes the overflights observed during the course of the experiments and the responses of the turkeys. Appendix F provides all the detailed information available. Figure 3-5 shows the sequence of sound exposures by aircraft type. A total of 32 overflights were logged over the 5 days of observations, with at least two per day exceeding a sound exposure of 100 dB.

Table 3-1 shows the distance calculated from the photographs. These distances were used to supplement the visual estimates, especially for aircraft more than 500 m from the camp

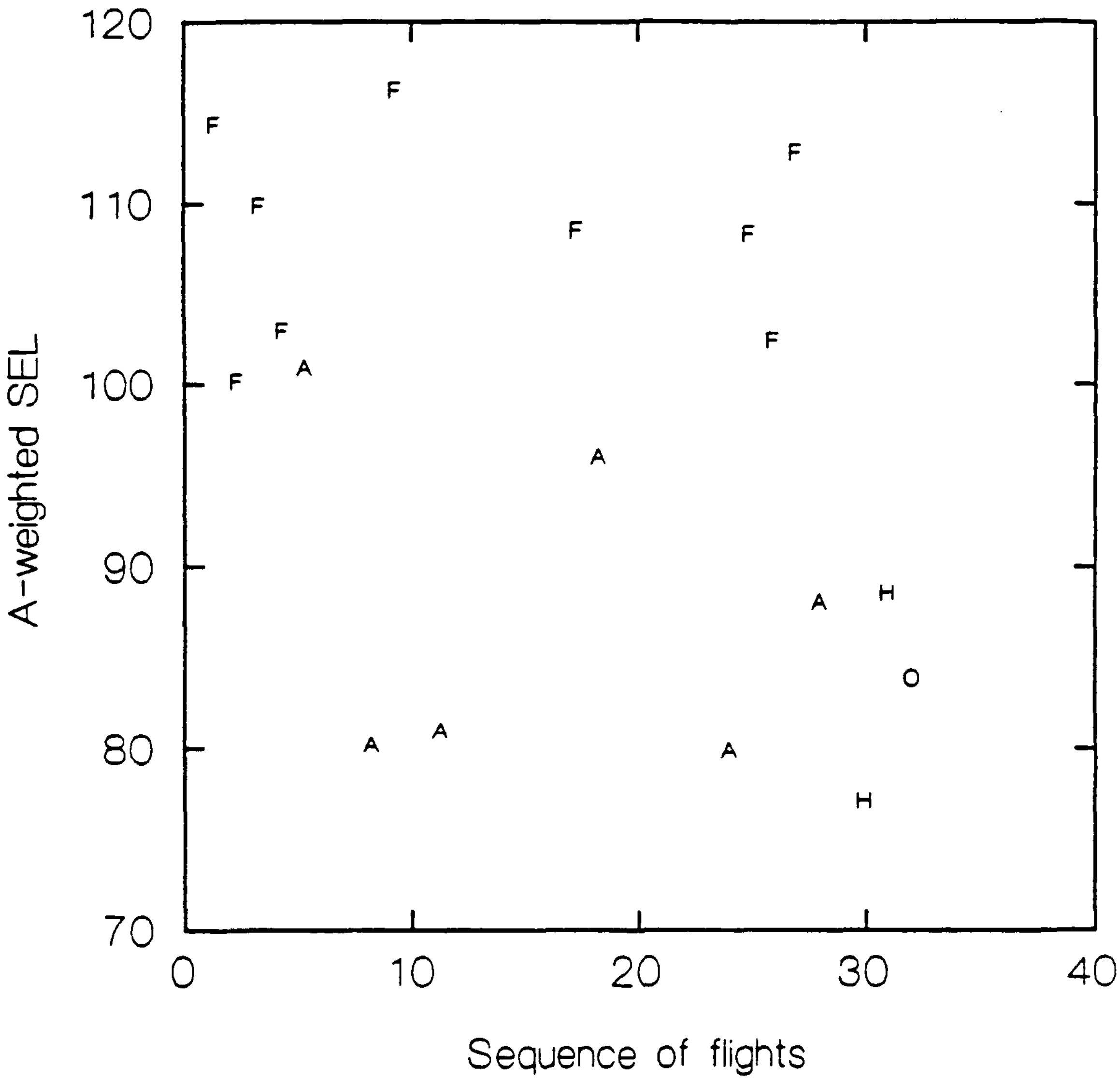


Figure 3-5. Sequence of Exposures to Overflights During Subtask 2. Jets coded "F" are F-4s and F-18s. Jets coded "A" are A-6s and A-4s. "H" indicates a helicopter. "O" indicates an OV-10 surveillance aircraft.

Table 3-1. Slant Distance of Aircraft Calculated from the Photographs Taken during Experiment 2.

Slant distance calculations									
Photo No.	Aircraft Type	Date	Time	Flight Number	Length on Photo (mm)	Length on Neg (mm)	Comments	Aircraft Length	Slant Distance (m)
24	C-130	5 Apr	11:01	17	11	1.64	Slanted	29.79	3641
25	C-130	5 Apr	15:10	21	9	1.34	Slanted	29.79	4450
26	C-130	5 Apr	15:10	21	19	2.83	Good	29.79	2108
23	C-130	5 Apr	11:01	17	17	2.53	Good	29.79	2356
21	OV-10	5 Apr	9:40	15			Slanted	12.67	
6	OV-10	6 Apr	13:58	28	10	1.49	Slight Slant	12.67	1703
5	OV-10	6 Apr	13:58	28	9	1.34	Good	12.67	1893
4	OV-10	6 Apr	13:58	28	10	1.49	Slanted	12.67	1703
13	OV-10	6 Apr	14:09	31	28	4.17	Good	12.67	608
11	OV-10	6 Apr	14:09	31	31	4.61	Good	12.67	549
20	OV-10	5 Apr	9:40	15	48	7.14	Good	12.67	355
28	A-4	5 Apr	14:37	20	8	1.19	Good	12.24	2057
27	A-4	5 Apr	14:37	20	8	1.19	Good	12.24	2057
29	A-4	5 Apr	14:37	20	7	1.04	Good	12.24	2351
30	A-6	5 Apr	17:28	23	18	2.68	Good	16.64	1243
10	F-18	3 Apr	15:40	8			Slanted	17.07	
34	F-18	6 Apr	8:55	25	33	4.91	Good	17.07	695
3	F-4	3 Apr	8:35	5	53	7.88	Good	17.76	451
1	F-4	3 Apr	8:35	5	11	1.64	Blurry	17.76	2171
2	F-4	3 Apr	8:35	5	12	1.79	Good	17.76	1990
4	F-4	3 Apr	8:35	5	35	5.21	Slight Slant	17.76	682
8	F-4	3 Apr	8:35	5	24	3.57	Slanted	17.76	995
33	F-4	6 Apr	8:32	24	28	4.17	Good	17.76	853
15	F-4	4 Apr	11:31	10	53	7.88	Good	17.76	451
14	F-4	4 Apr	11:31	10			Slanted	17.76	
6	F-4	3 Apr	8:35	5			Slanted	17.76	
32	F-4	6 Apr	8:32	24	23	3.42	Good	17.76	1038
31	F-4	6 Apr	8:32	24	26	3.87	Good	17.76	918
26	Tower				9	1.34	Good		182*
22	F-18	5 Apr	10:10	16	8	1.19	Good	17.07	2869
11	F-18	3 Apr	15:40	8	7	1.04	Good	17.07	3279
7	Bell 206	6 Apr	14:02	29	25	3.72	Good	9.1	489
9	Bell 500	6 Apr	14:06	30	125	18.60	Good	9.1	98

(i.e., more than two tower heights up or outside the power lines). The photographs were not as reliable at dose range because aircraft were difficult to photograph at the exact moment of closest approach--especially when traveling in groups. Ranges within 500 m were good to 50 m. Ranges outside 500 m were estimated to the nearest 500 m.

As observed in Experiment 1, latencies to preening and calling after the first two exposures never approached the initial values. The latencies in response to a first exposure of comparable sound level (115 dB in Experiment 3) were 150 seconds in the lab; enclosed birds at the Mojave site waited 285 seconds. Subsequent latencies did not exceed half these values. The difference between the two values is explained by the method of measuring latencies, not differences between field and lab response; in the field latencies were measured from the start rather than the end of an event because event end was impossible to define in the field.

The turkeys usually oriented on the aircraft until it had passed out of sight. Von Rhein's (1983) chickens behaved similarly, crowding around small openings in their barn to see out when an aircraft loomed overhead. The birds in the Mojave often travelled to the side of the pen that gave them a clear view of the aircraft and watched it intently as it passed over. The turkeys in the open pen travelled to the side facing the most common direction of travel (south to north along IR 213/212). The turkeys in the closed pen travelled to the camera opening at the opposite end of the pen and craned their necks in an attempt to see the aircraft around the cloth covering. Occasionally they could see aircraft flying along VR 1217 that way. The turkeys in the open pen usually waited a little longer before returning to normal, presumably because they were watching the aircraft.

Figure 3-6 shows the latencies to first cohesion call and preen after all overflights. Both latencies from the start of the overflight (latencies) and latencies from the end of the overflight (corrected) were measured. Latencies varied little (see Figure 3-6A and B) and were similar for both behavioral measures in both pens. Variances were greater for corrected latencies (see Figure 3-6C and D), largely due to the difficulty of defining the end of the overflight. We abandoned this measure.

Figure 3-7 summarizes the latencies by aircraft type. As expected, the longest latencies were observed in response to F-4 jets and helicopters. The F-4s were flown at the lowest altitudes and

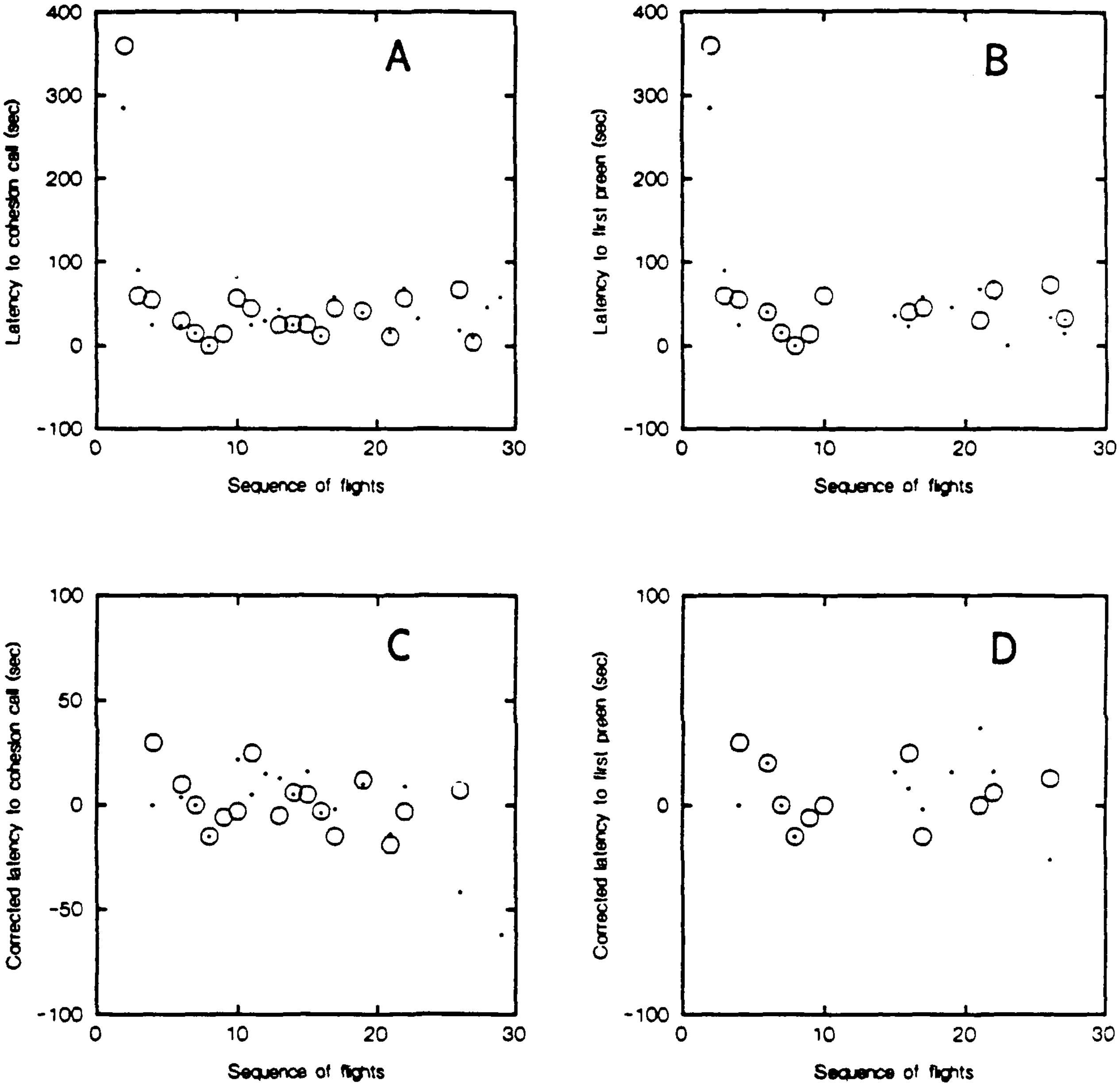


Figure 3-6. Latencies to Calling and Preening After Actual Overflights. Latencies to first call and first preen--A, B. Corrected latencies to first call and first preen--C, D (latency minus duration).

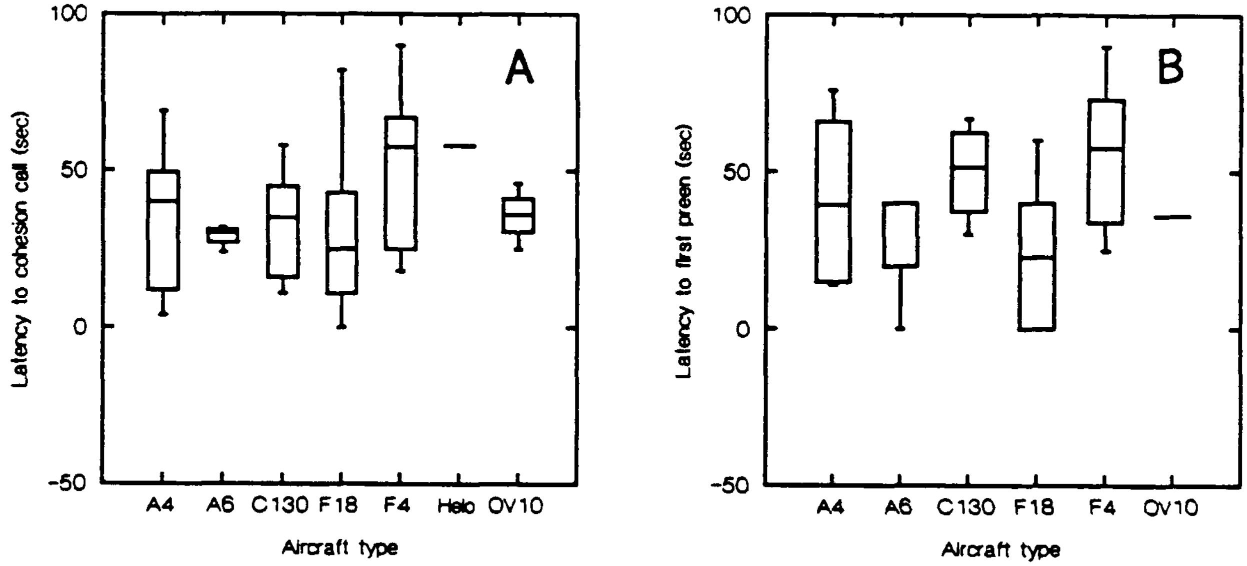


Figure 3-7. Comparison of Latencies by Aircraft Type. A-B show uncorrected latencies.

therefore exposed the turkeys to the highest sound levels and the best visual targets. Return-to-normal behaviors for all turkeys that responded were measured from videotapes of both the covered and open pens. Matched sets of observations were available for F-18, OV-10, and helicopter overflights with more than five responses per overflight. The results are summarized in Figure 3.8. Statistical comparisons of all response latencies (mostly time to relaxing and time preening) showed no difference between pens (N = 36 responses to helicopters, P = 0.536; N = 43 responses to F-18 aircraft, P = 0.616; N = 32 to OV-10 aircraft, P = 0.255).

Figures 3-9 and 3-10 show the relation between latencies and sound level, SEL, distance to aircraft, and interval since previous aircraft overflight.

We reanalyzed the data, confining the observations to those of F-4 and F-18 aircraft and excepting the first two overflights. Figure 3-11 shows the corrected and uncorrected latencies versus sound level for these data. Response latencies increased with sound level, increasing more sharply above 90 dB; this is consistent with the published literature on response thresholds (Thiessen, 1957; Thiessen *et al.*, 1957). Figure 3-12 shows the relation with duration of the overflight. Figure 3.13 shows the relation to aircraft altitude. Thus, distance from aircraft, duration of overflight, and sound level all played an important role in predicting the latency of the response.

Figure 3-14 shows the relation between SEL (which varies with duration as well as sound level), distance and latency. This representation shows more clearly the sharp increase in response latency with SEL from 90 to 100 dB and to approach distances within 300-400 m.

3.2.2 Responses to experiments

Figures 3-6 to 3-10 show latencies by pen, which did not differ significantly (one-way ANOVA, P=0.2). Response latencies of individuals in both pens were also compared from the videotaped results of the simulation experiments. They did not differ significantly between pens (P>>0.10). Figure 3-15 shows the sequence of experiments and overflights during the last two days of observations (responses of both pens are shown combined). Responses to simulated overflights were

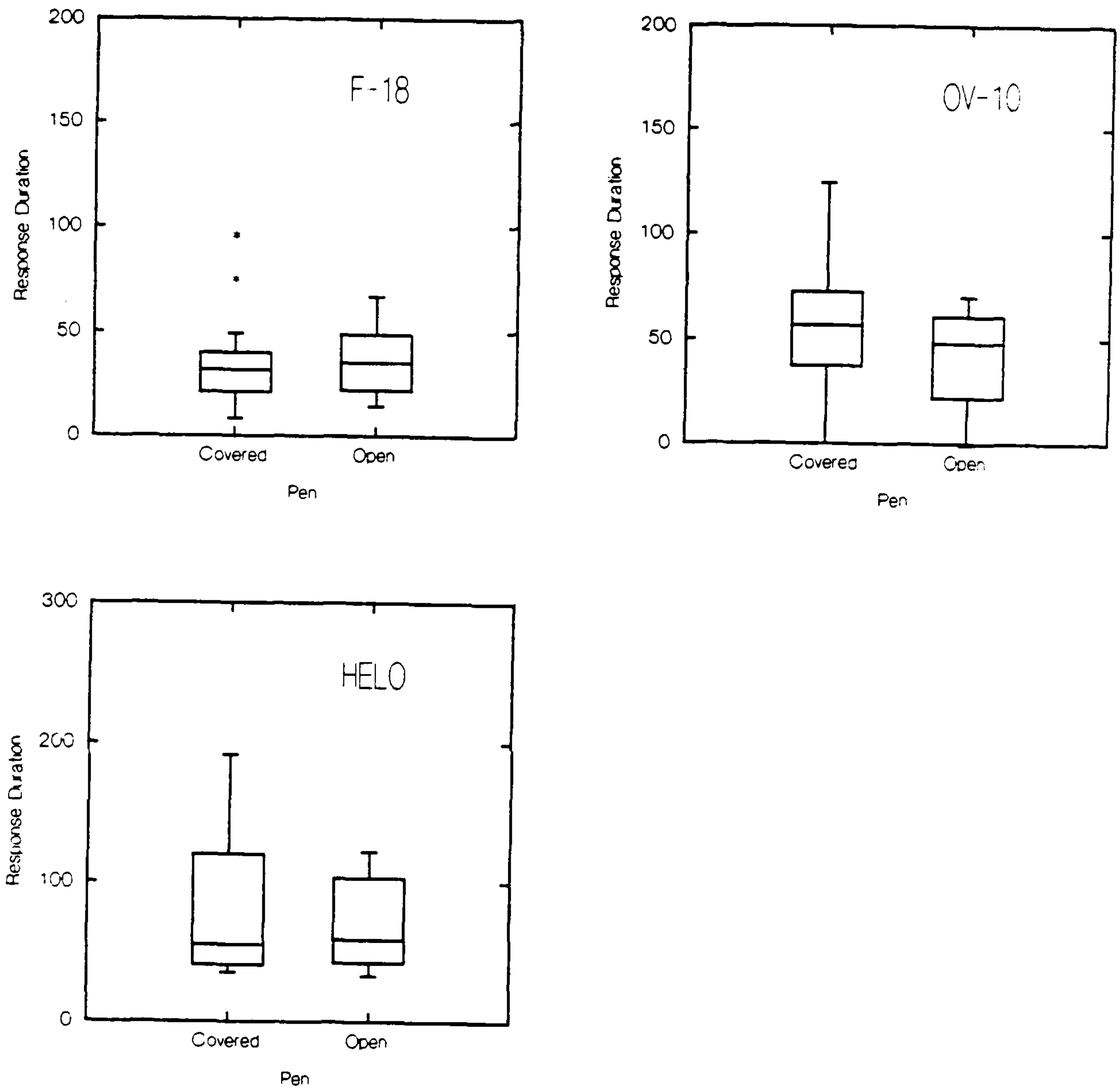


Figure 3-8. Response Latencies of Birds in Covered and Open Pens after Exposure to F-18 Jet Fighters, OV-10 Survelliance Aircraft, and Helicopters. Latencies were measured as the time from initial alerting response to return to normal activity (e.g. relaxing, eating, preening, calling, and walking). Differences between the two pens were not significant. The center bar in these box plots is the median, the box marks the first quartile boundary, and the whisker marks the second. Outliers are marked with asterisks and circles.

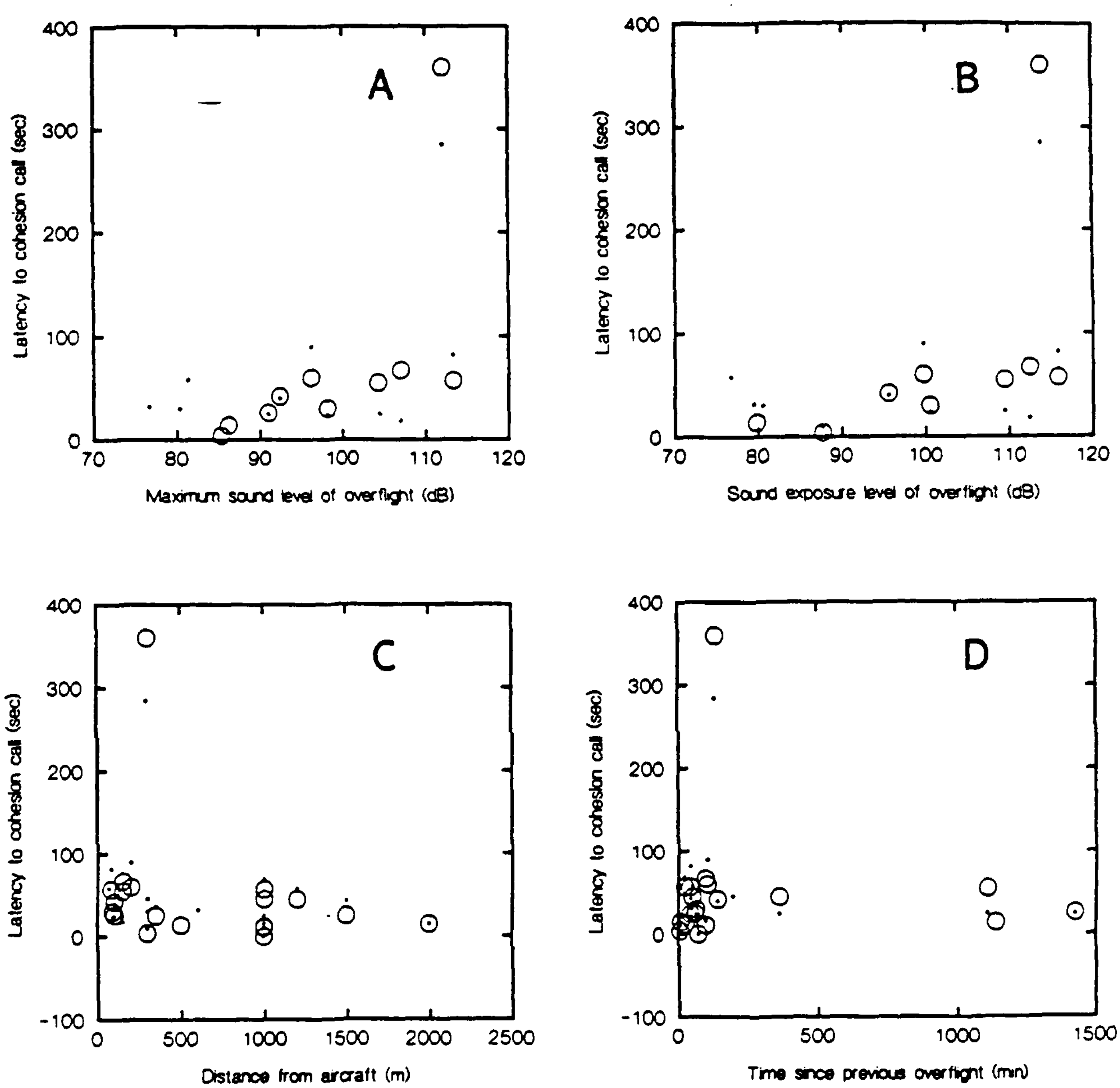


Figure 3-9. Latencies to First Cohesion Call Plotted Against Sound Level (A), A-Weighted Sound Exposure Level (B), Distance of Aircraft (C), and Interval between Overflights (D).

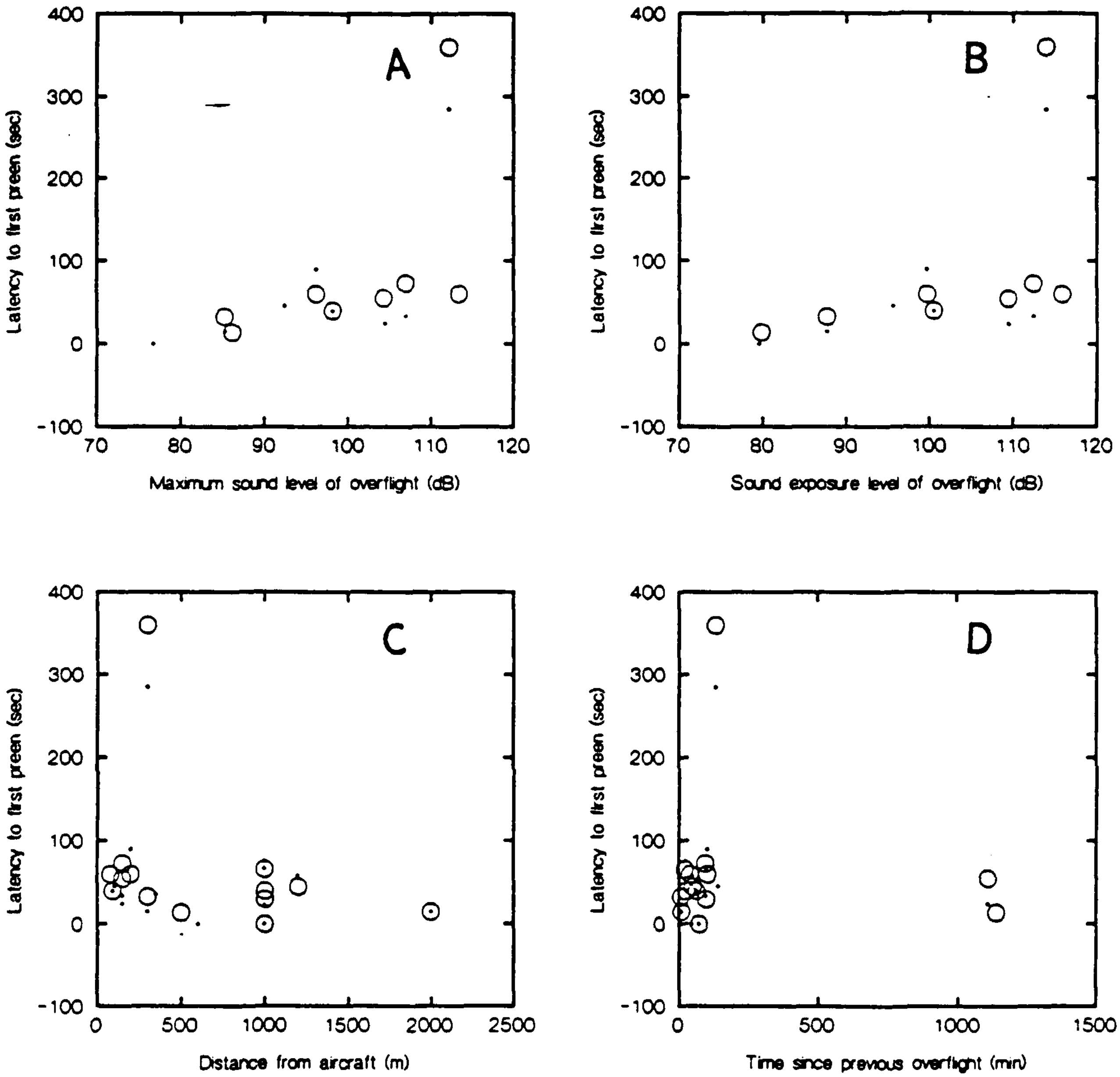


Figure 3-10. Latencies to First Preen against Sound Level (A), A-Weighted Sound Exposure Level (B), Distance to Aircraft (C), and Interval between Overflights (D).

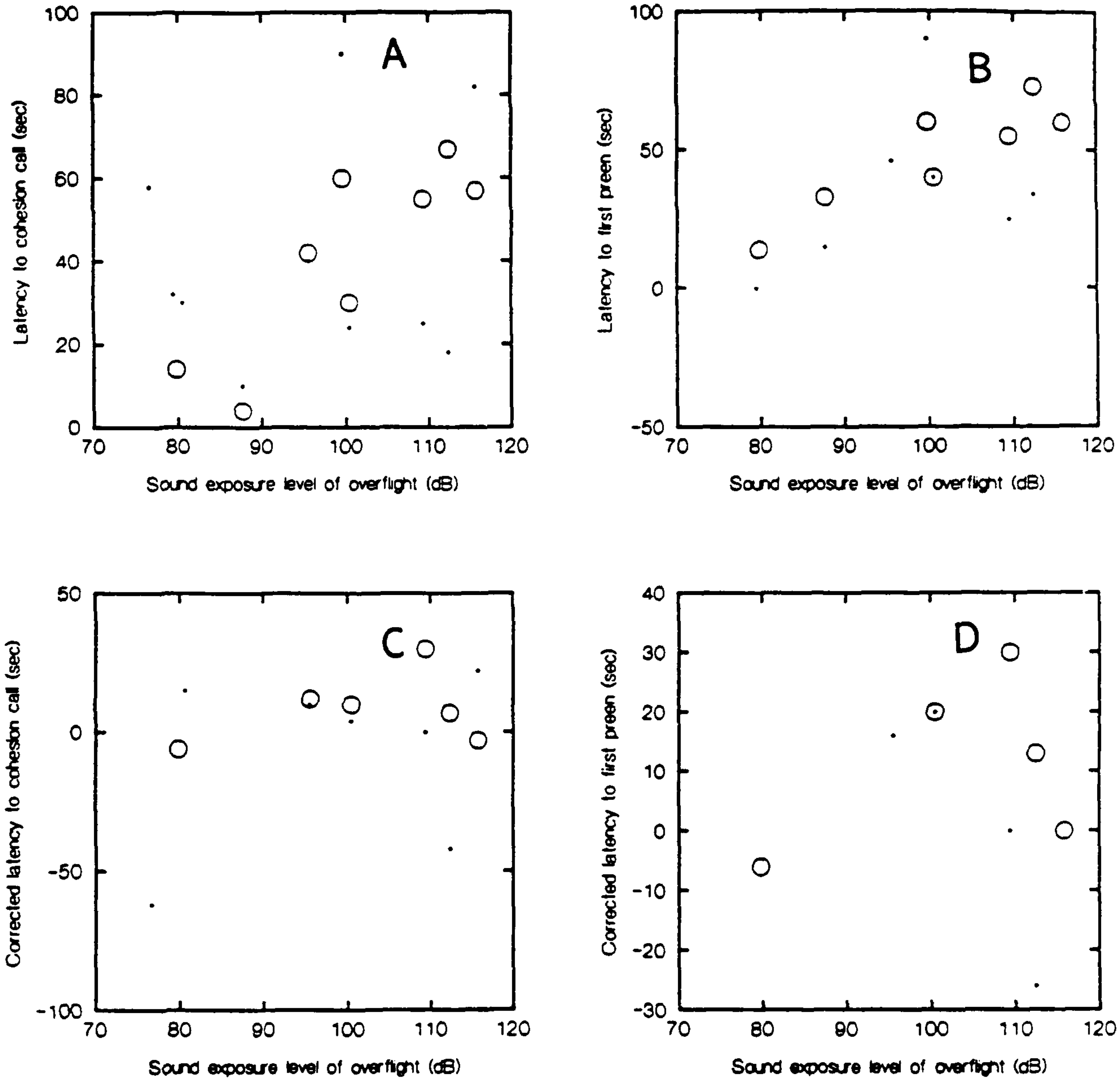


Figure 3-11. Latencies to First Cohesion Call (A,C) and First Preen (B,D) Versus Sound Exposure Level for F-4 and F-18 Aircraft Only. The values exclude the naive response to the first overflight.

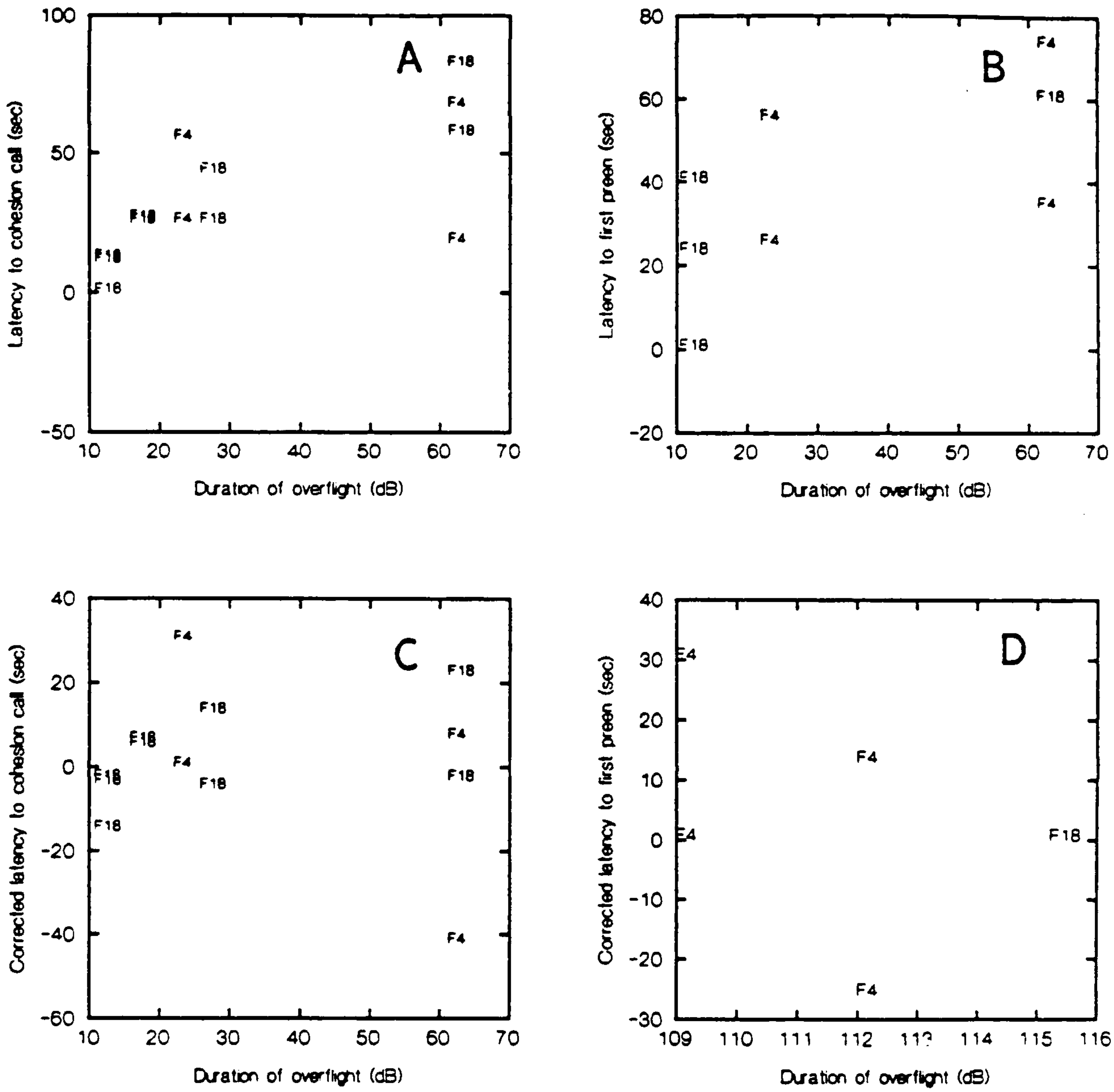


Figure 3-12. Relation between Duration of Overflight and Latencies to First Cohesion Call (A,C) and First Preen (B,D).

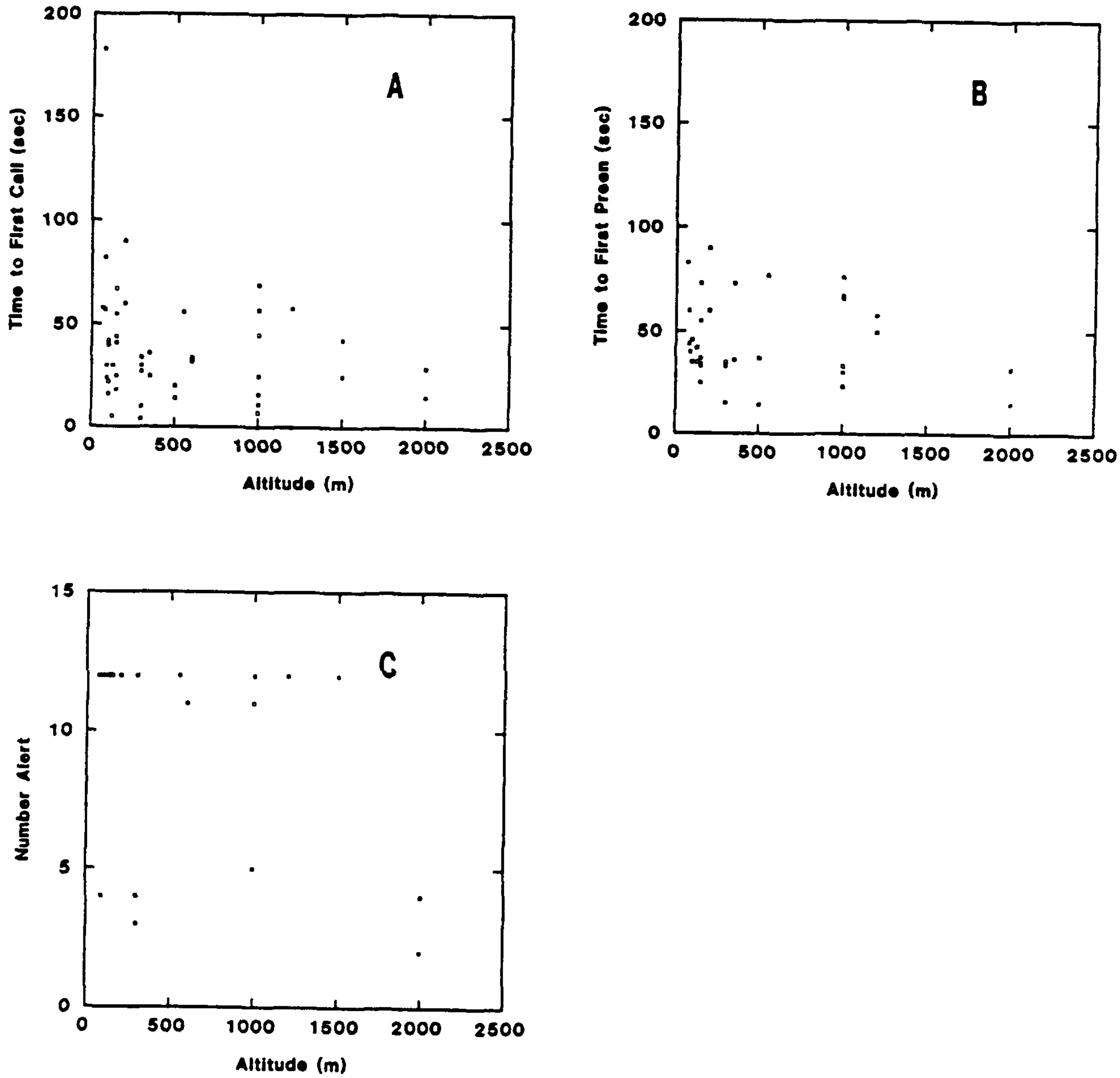


Figure 3-13. Relations between Aircraft Distance, Latency to First Call (A), Latency to First Preen (B), and Number of Birds Alerting (C). The naive response to Flight 2 was not included in these graphs.

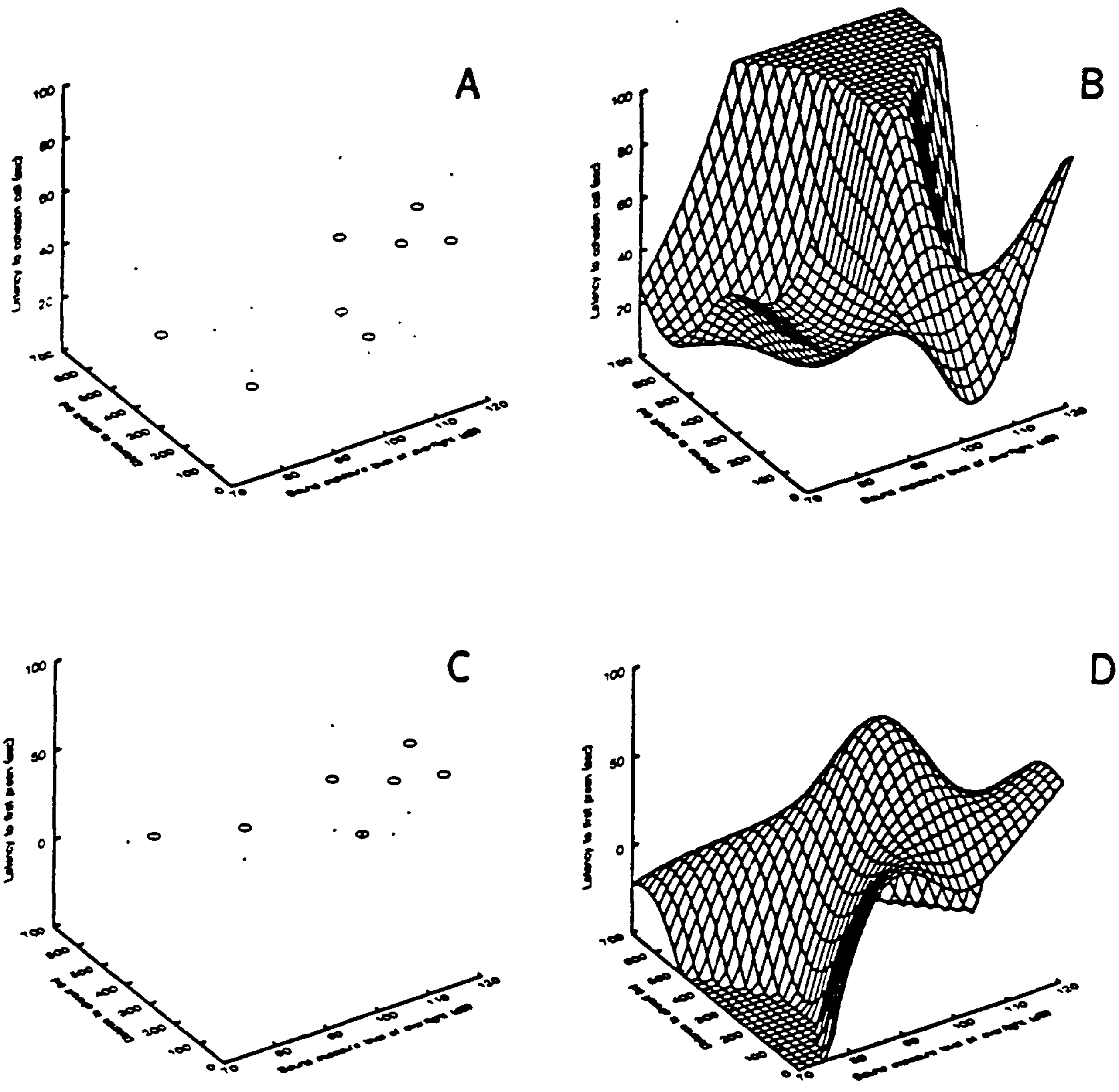


Figure 3-14. Three Dimensional Representation of the Effects of Aircraft Distance to Aircraft Sound Level on Latencies to First Cohesion Call (A,B) and First Preen (C,D). The smoothed version on the right (B,D) shows an exponentially-smoothed surface to highlight the sharp increase to responses at 90-100 dB and below 400 m distance. These values exclude the initial naive response.

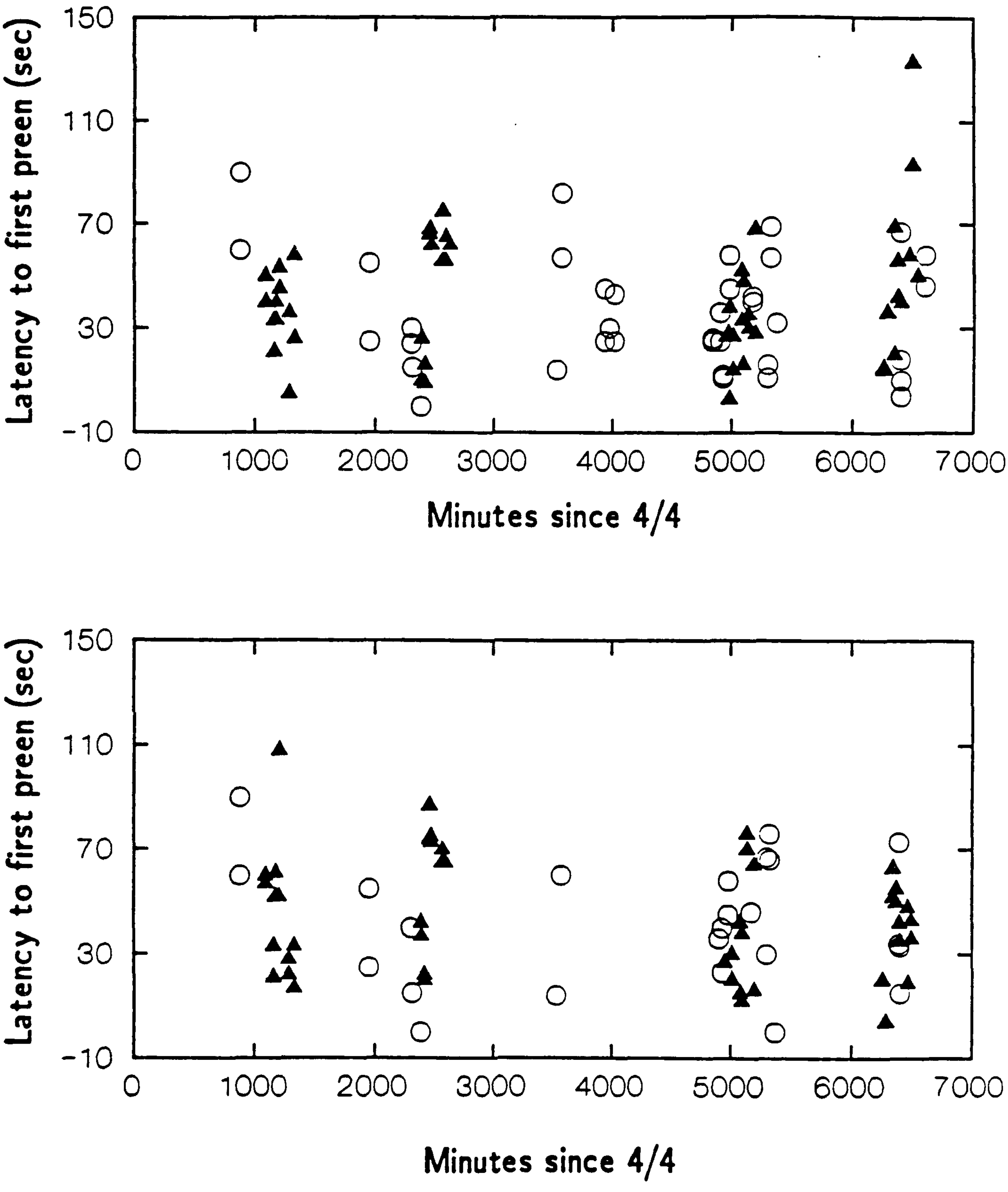


Figure 3-15. The Sequence of Responses by Birds in Both Pens during the Experiments on 5 and 6 April. The diamonds indicate responses to experiments and the open circles indicate responses to aircraft overflights. The time line was calculated in minutes subsequent to 2400 hours on 4 April.

similar to those to actual overflights, at least as measured by latencies. The wide variation in the latencies is explained by diurnal temperature changes (turkeys responded less during the hot part of the day).

Three recordings of F-4 and F-18 overflights were made during the first three days of observations. These were used as the playback stimuli. The experiments were patterned after the procedure used in Experiment 1, with a low-level habituating stimulus preceding an intense test stimulus. We wanted to know whether this low-level stimulus could be used to extinguish startle responses to aircraft or to higher-level playback stimuli. Table 2-8 and Figure 3-16 show the latency to first call by experiment type.

The first and second stimuli had levels of 80 and 92 dB, respectively. The third was made from one channel of a two-channel recording (played simultaneously from two speakers, one over each pen), with a level of 96 dB. The fourth was created by playing both channels from the speakers; it was played only twice, and had a level of 102 dB. The fourth stimulus produced an acoustic image that moved in perceptual space from one pen to the next, although it did not produce a true stereo image. The initial playback of this stimulus produced the longest latencies observed after any experiment, although it was conducted at the end of two days of playback experiments. The sound level of the stimulus was slightly higher than its single-channel counterpart (102 dB versus 96 dB), so some of the difference could have been explained by sound level (this range is near the response threshold). However, the novelty of the stimulus probably played the most important role--the latencies after this stimulus were longer than those after aircraft overflights of similar or higher sound level observed the same day.

Onset rates were measured for a few of the overflights from recordings; all were in the range of 25-35 dB per second, so no conclusions can be reached about the importance of onset rate.

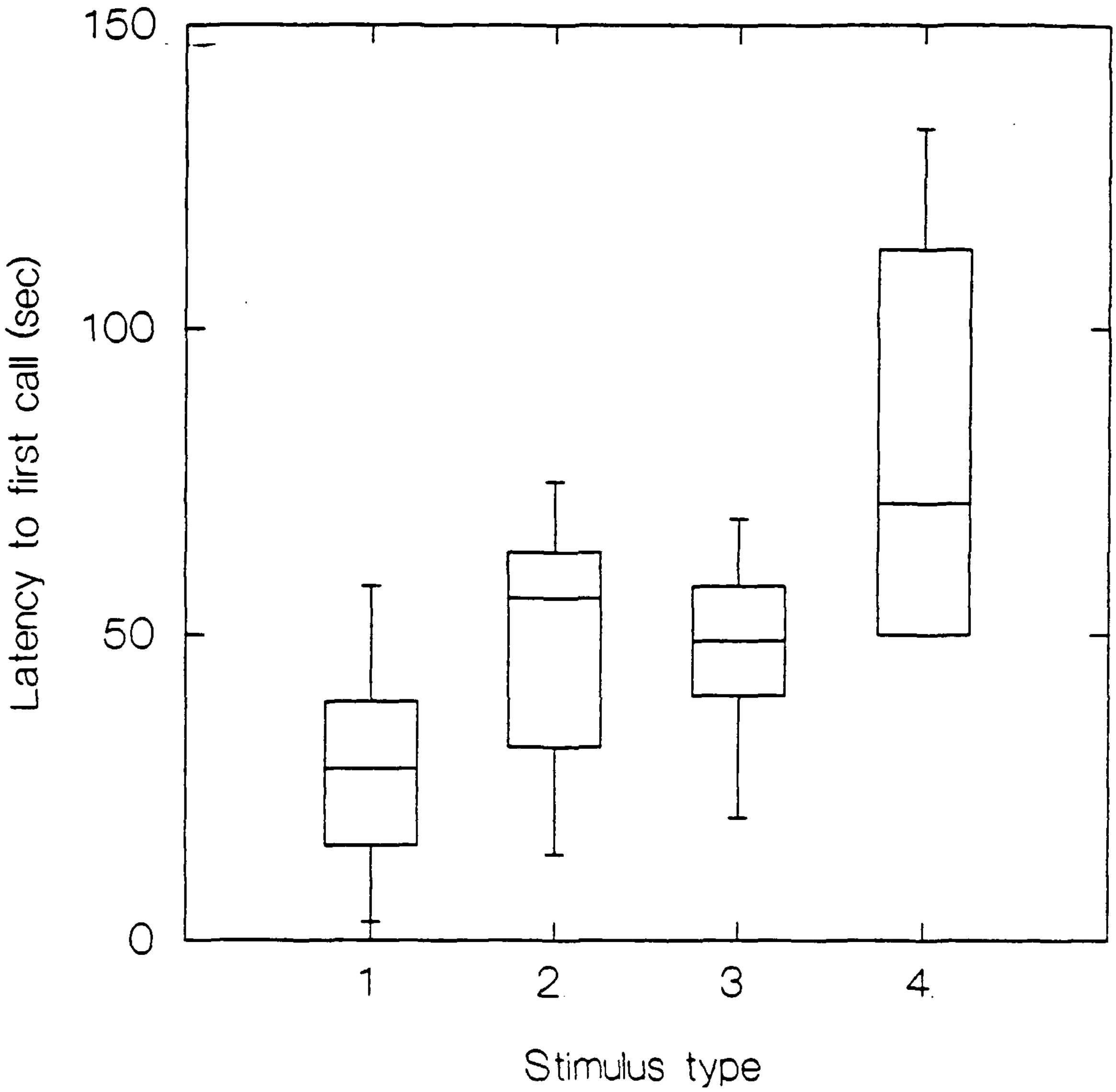


Figure 3-16. Latency to First Cohesion Call by Stimulus Type. Differences between stimuli 2 and 3 are probably explained by habituation. See Table 2-8 for the sound levels of the stimuli.

3.3 Experiment 3: Determining Effects of Aircraft Noise on Behaviors, Growth, and Carcass Quality of Naive Turkey Poults

3.3.1 Behavioral responses to sound exposures

Figure 3-17 shows the responses of turkeys to the sound stimuli presented in Experiment 3 and Appendix B lists the sequence of exposures. Behavior data for Experiment 3 were analyzed using the SAS program (SAS, 1985) with a general linear model ANOVA package (repeated measures ANOVA). Significant pairwise differences were analyzed using Scheffe *post hoc* comparisons.

Naive birds exposed to the most effective stimulus (115 dB maximum sound level at 25 dB per second) responded with panic flight, crowding, and piling. By the second exposure, this response was extinguished and did not reappear with repeated exposure to any of the five stimuli used in these experiments (see Figure 3-17). The 100 birds in the pen immediately below the speaker (see Figure 2-7) panicked, running and flying into one corner of the enclosure. All the birds crowded and there was some piling. They remained alert and crowded for over a minute after the exposure. It was over 140 seconds before normal cohesion calls resumed. The response began with the birds closest to the speaker and spread outward. Unfortunately, a videotape of this initial response is not available. No birds were lost or injured in the panic.

The first five exposures to the most effective stimulus (115 dB at 25 dB per second) were monitored by observers. Thereafter, exposures were monitored every fourth sound exposure. Latency to first preen and cohesion call were significantly elevated for the first five exposures ($P<0.02$ preen; $P<0.05$ call) compared to those following. Observation 42 was also significantly different from the rest. This exposure occurred on a windy day following two incidents of cannibalism the night before. The birds were exceptionally active, restless, and aggressive that day. Other rises in latencies were associated with changes in the environment (an intrusion by a sheep; a heat wave).

Frequency of alarm calls was significantly elevated at observations 1-3, 8, 25 and 42 (Figure 3-18, $P<.046$). Observations 1 and 42 were significantly different from the rest at $P<.012$. The response after observation 42 was the only one that approached the initial response. This response was facilitated by a pre-existing disturbance. During the first two exposures, the birds changed

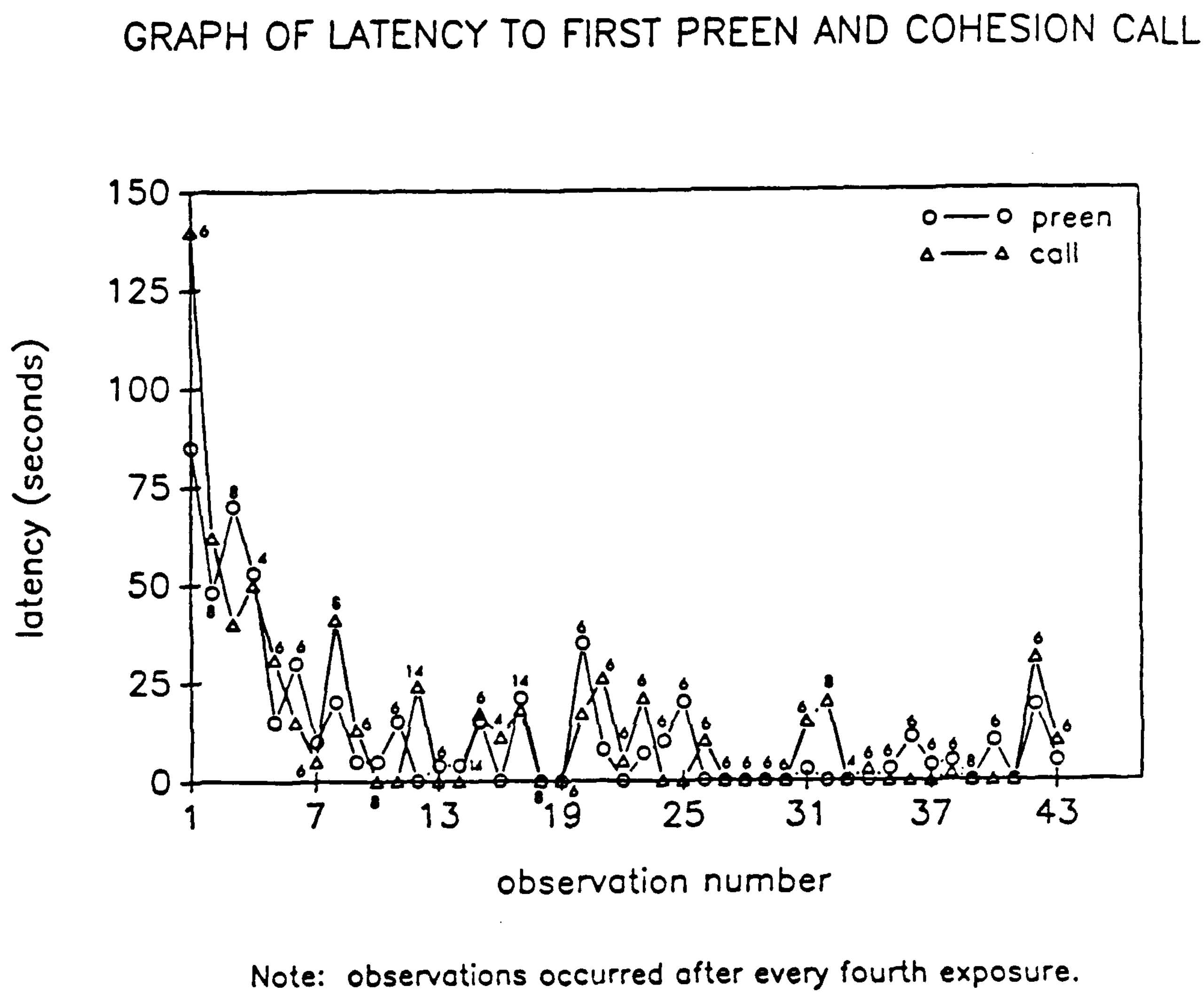


Figure 3-17. Sequence of Stimuli and Responses in Subtask 3. The responses were measured by observers on site every fourth experiment. The numbers over each point are the identity of the stimulus (see Table 2-3).

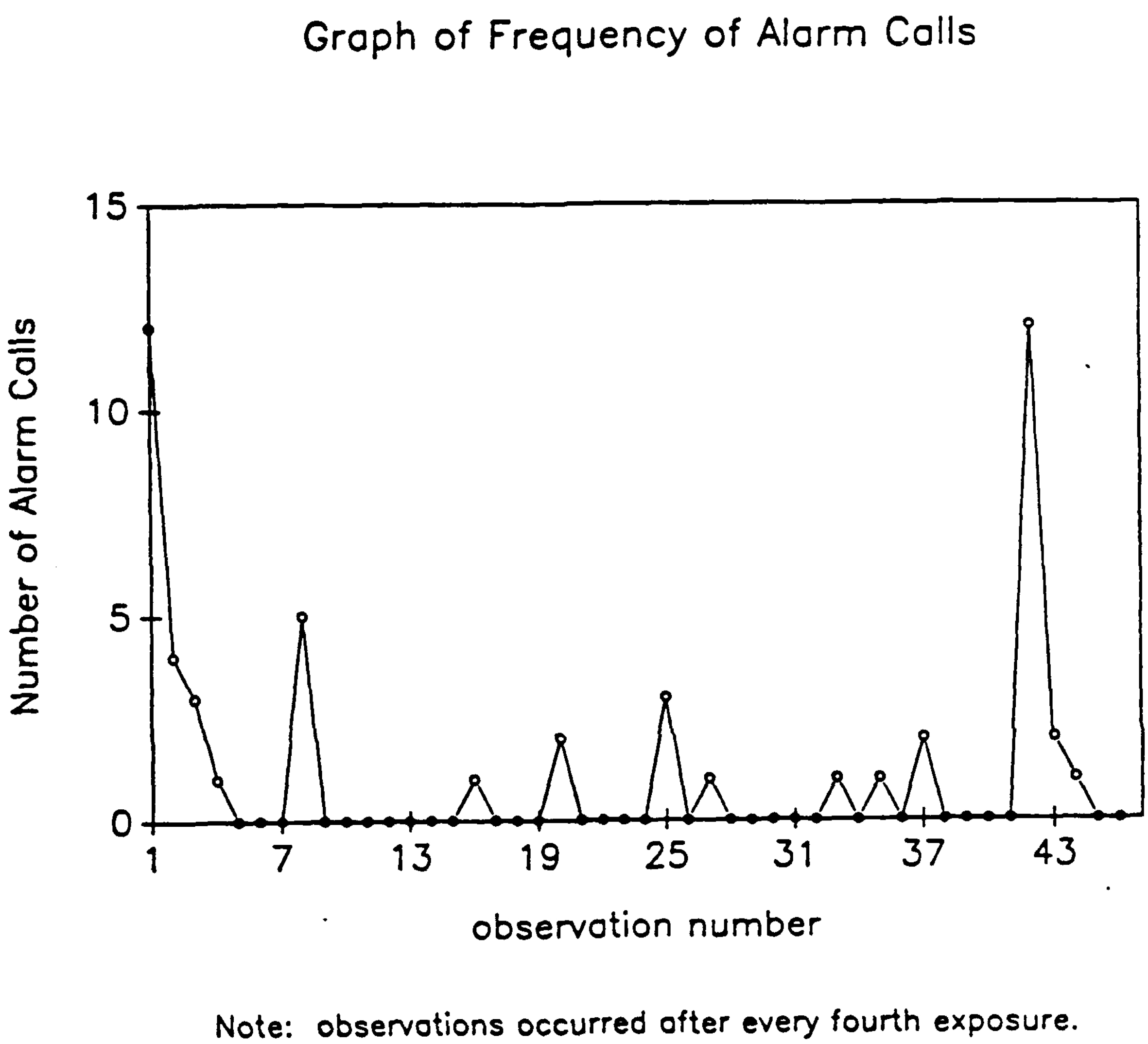


Figure 3-18. Sequence of Alarm Call Responses in Subtask 3. The large peak at observation 42 was the result of previous arousal by another stimulus.

cohesion (aggregated) after the sound exposure. Looking at only the first week of exposures, the first two exposures were significantly different at P<.09.

3.3.2 Analysis of growth rates

There were no differences in body weights at the beginning of the experiment between barns (P<.813), as expected. There were no differences in body weights between control and experimental groups at the end of the experiment (repeated measures ANOVA, P<.761), for the matched sets of control and experimental pens (see Figure 3-19). If data are analyzed weighing-by-weighing, there is a significant difference between the two in the last week of the experiment (week 16; Student's T test, P<.05). However, all weights, including the ending weights, exceeded or met industry standards as given by the Utah Strain Test (Warnick, 1988) and Turkey Growth Standards (Sell, 1990).

There was an effect of pen size on weight gain (ANOVA, P<.043) during the course of the experiments. The hens in pens with 100 birds were significantly larger than hens in pens with 20 birds. The hens in pens with 40 birds were intermediate in growth rate, and did not differ significantly from either of the other two, although they were the least exposed. Note that the greatest weight gain was associated with the pen receiving the highest exposures (see Figure 3-20), and that the trend in the control barn was the same as in the experimental barn. This suggests that the effect on weight was the result of group size and not sound exposure. The effect was detectable in all weeks after the birds reached 12 weeks of age. The variances in weights did not differ significantly between the two barns.

3.3.3 Analysis of feed consumption

Feed consumption did not differ significantly between the control and experimental barns (P<.183), although the birds in the experimental barn ended up eating 7.3% more feed throughout the course of the experiment (see Figure 3-21). This difference in feed consumption was consistent throughout the study period and can be explained by the increased activity in the experimental barn.

The feed intake to gain ratio (feed intake [lbs]:weight gain [lbs]) did not differ between the barns (repeated measures ANOVA, P<0.16), although there was a trend toward more fluctuations

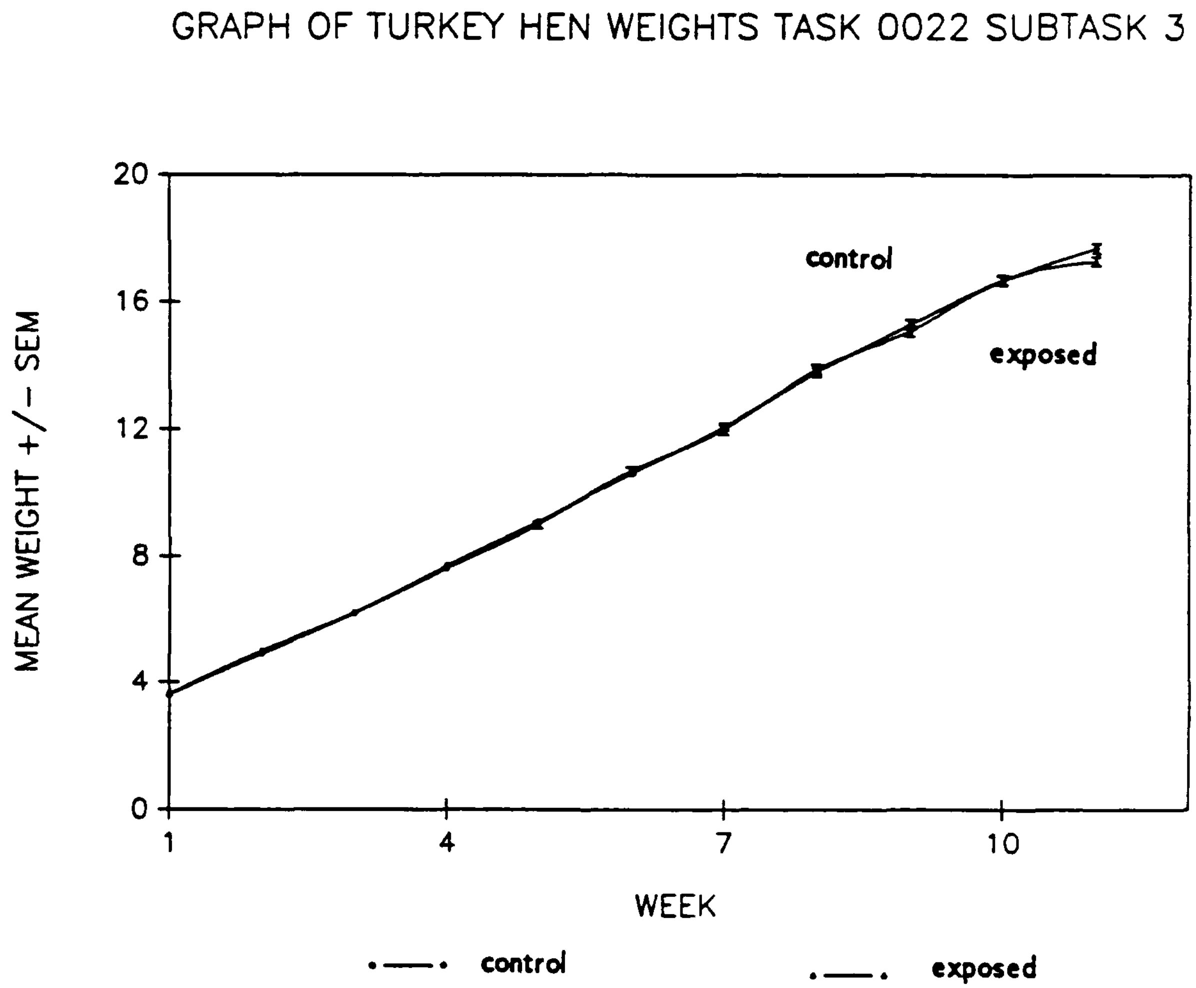


Figure 3-19. Comparison of the Weekly Weights of Turkeys in Control and Exposed Groups. Error bars represent the standard error of the mean.

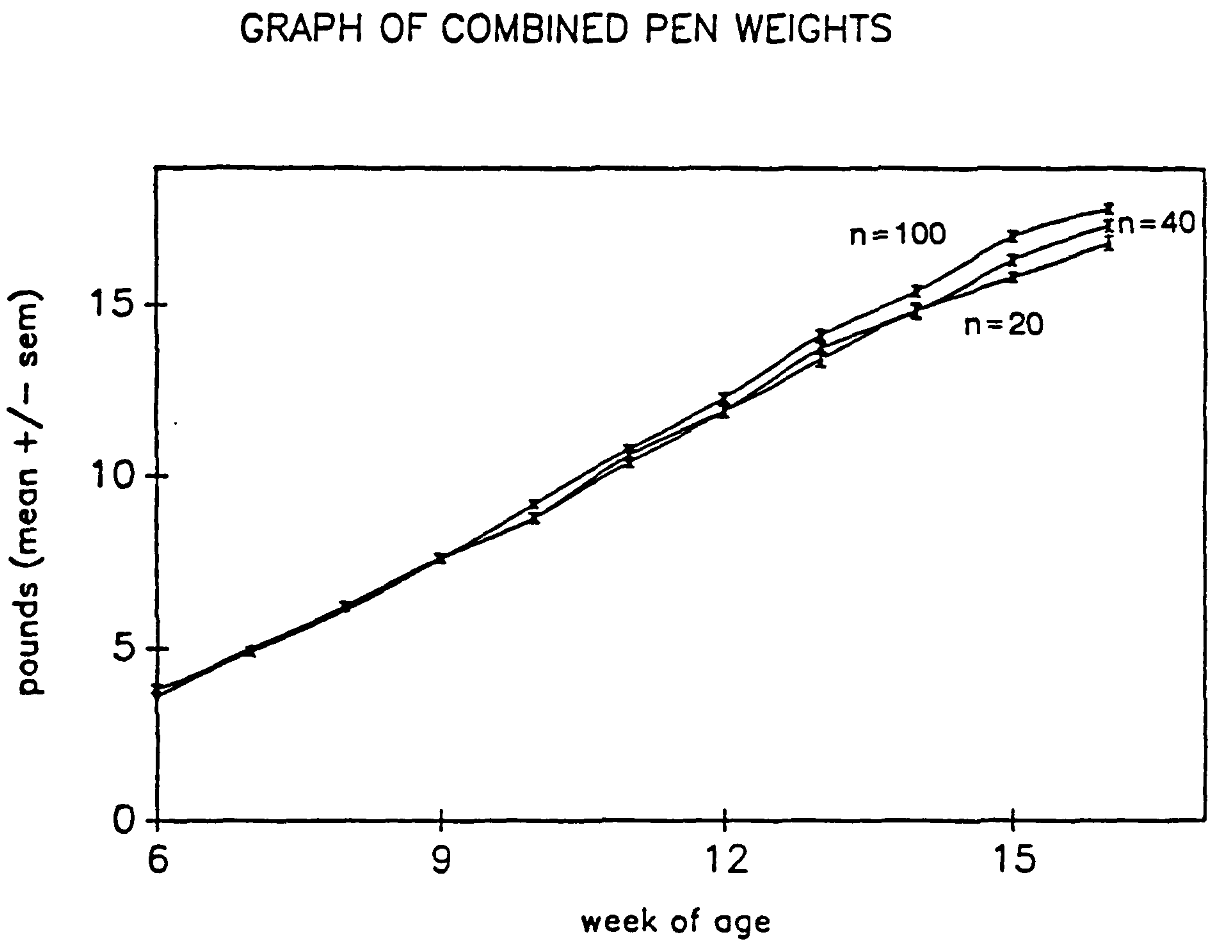


Figure 3-20. Graph Showing Weights of Birds during the Course of Experiment 3 Broken Down by Pen (20, 40, and 100 poult pens). The error bars in this figure are standard errors.

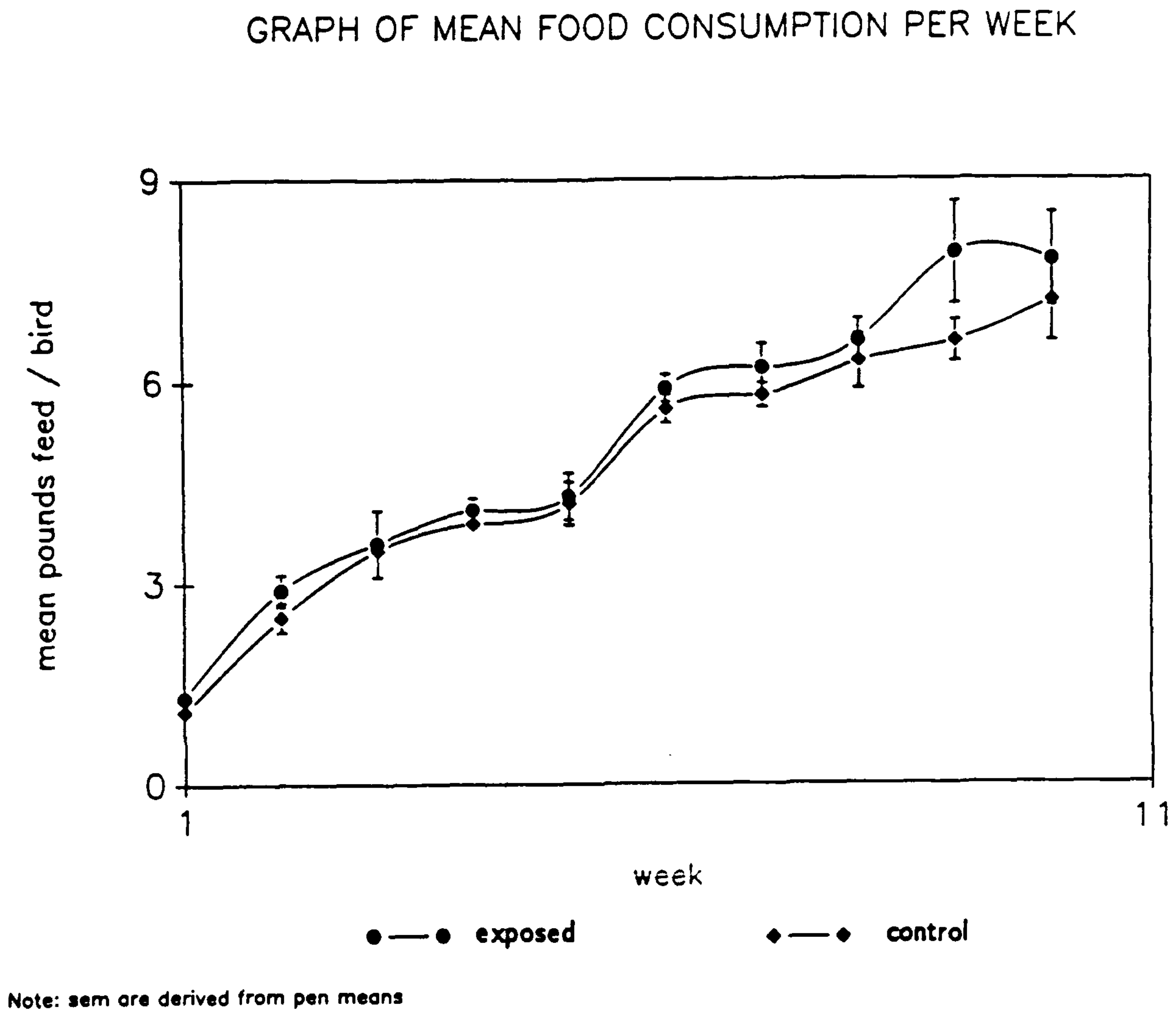


Figure 3-21. Feed Intake by Control and Experimental Groups during the Course of Subtask 3.

in the ratio in the experimental barn. The intake-to-gain ratio is shown for both control and cxposed groups in Figure 3-22 (weights measured from 6-17 weeks of age). There was a sharp increase in the ratio after 12 weeks of age.

Both groups consumed more feed than would be expected, probably because they were fed a low-energy ration. This low-energy ration was chosen due to its availability in small quantities, but was not as efficient per pound of meat produced. A small proportion of the feed may have been eaten by rodents, but rodents were controlled in both barns very soon after they appeared and are not likely to have consumed much feed. There was a small amount of feed spillage (10-20 lb in over a ton of feed).

3.3.4 Analysis of losses of marketable birds

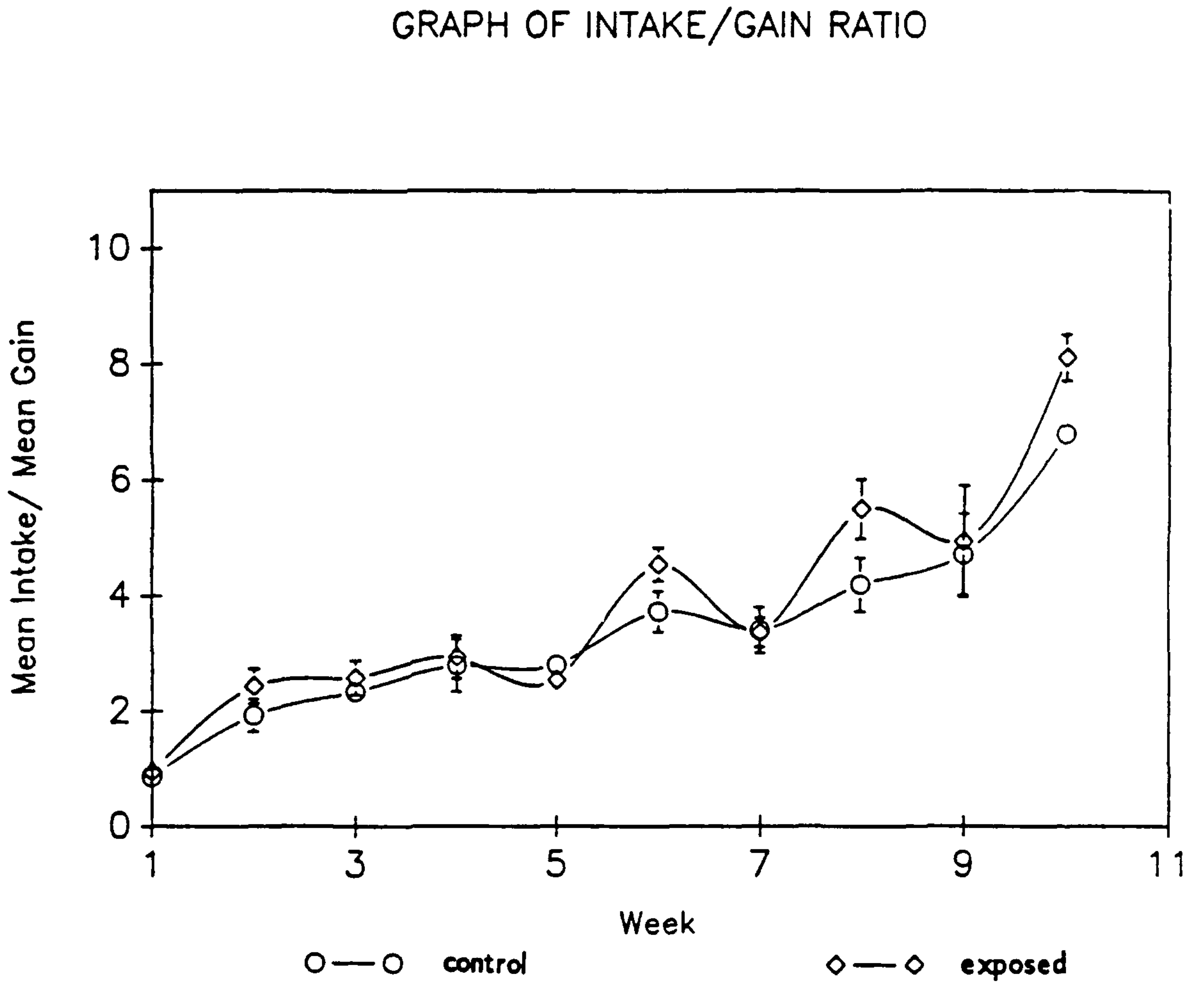
The numbers of birds lost varies widely in actual commercial practice. Although losses in large commercial turkey flocks are small (2-4%; Utah Agricultural Research Station, 1989), a loss rate of 7-10% is typical of small operations. The categories of losses observed may be defined as follows (incidence estimates from Warnick, 1988):

- **Picking**: An individual can be injured when another bird picks at it, usually around the head and neck. Bleeding stimulates further picking by other birds, and severely picked birds are removed and culled.

- **Leg problems**: Because of the high relative mass of meat on commercially-bred turkeys, the legs are prone to structural problems, including fractures, strained ligature and badly-formed bones. Incidences can be quite high in commercial practice (30%), but typically run 1% or less. Birds with injured or deformed legs are culled.

- **Deformities**: Debilitating deformities, such as cross-beak, are usually culled at the hatchery. They are certainly culled as soon as they are discovered.

- **Heart attacks**: Turkeys are prone to sudden cardiac arrest. In standard practice, less than 1% of birds are lost this way.



Note: sem are derived from pen means

Figure 3-22. Ratio of Feed Intake to Weight Gain over the Course of Subtask 3 for Both Experimental and Control Groups.

- **Cannibalism**: Birds that bleed, especially from picking, can be cannibalized before they are identified and culled. The normal incidence of cannibalism is less than 1%.

Other sources of loss (e.g., disease) constitute the remaining losses.

The causes of loss of hens in the experimental barn were cannibalism (1/160, 0.6%), picking (8/160, 5%), and leg problems (2/160, 1%). In the control barn, the causes of loss were picking (1/160, 0.6%), deformity (1/160, 0.6%), unknown but probably disease-related losses (2/160, 1%), and cardiac arrest (1/160, 0.6%). Total losses were 7% in the experimental barn and [illegible]% in the control barn. These loss rates are good, as losses of 7-10% are expected. However, the losses due to picking in the experimental barn were higher than expected (5% versus less than 1%). Observations made at the site indicated that several of the turkeys in at least two pens developed the tendency to pick, which resulted in higher injury rates and cullings.

A few words on cannibalism are in order. Hofstad (1984) reports that many forms of cannibalism occur in domestic fowl and game birds in captivity. The cause is often difficult to determine. Often outbreaks of cannibalism can occur in one pen, while similar environmental conditions or feeding practices in other pens or on the same farm do not cause any difficulty. Conditions reported as predisposing to cannibalism are feeding pellets or compressed feed, cafeteria system of feeding, excess corn in the ration, insufficient feeder or drinker space, being without feed for too long, excessively light pens, high-density rearing systems, too much heat, nutritional and mineral deficiencies, and irritation from parasites. If birds pick on one another or scratch each other in a piling incident, the sight of a fresh wound can stimulate cannibalistic behavior. Thus, the high incidence of picking in the experimental group puts them at risk for cannibalistic behavior. Whether this is due to a few individuals that develop the picking "vice" or whether it is due to the generally greater levels of activity in the experimental barn is unknown.

3.3.5 Analysis of grading turkeys after processing

There was a significant difference between control and exposed birds in the numbers of birds in grading classes A and B (Student's T, $P<.009$) after processing and evaluation. These differences are apparent even after removing birds handled weekly for the growth rate study, which were

somewhat more bruised due to handling. Figure 3-23 shows the numbers in each grade class for data on all birds. Figure 3-24 shows the values expected if the carcasses had been trimmed (carcasses are generally trimmed before evaluation; trimming allows ungraded individuals to be graded). If the birds that had been weighed are removed from the analysis, the results are even more striking. Table 3.2 shows the numbers after removing weighed birds from the analysis. Table 3-3 shows the numbers downgraded and reasons for downgrading in both experimental and control groups.

Table 3-2. Results of Grading the Turkey Carcasses After Trimming And After Removing the Birds That Were Weighed during the Course of the Experiments.

Grade	Experimental	Control
A	1 (3%)	22 (63%)
B	27 (77%)	11 (31%)
C	5 (14%)	2 (6%)
No Grade	2 (6%)	0 (0%)

The numbers of limbs broken or disjointed, lacerations, and crooked backs were similar in both groups, so the downgrading was entirely due to the types of surface damage (bruises and scabs) that would be expected if the birds picked on each other more or were much more active. The results of the behavioral observations suggest that both activity and fighting probably played a role, but since the exposed birds were more difficult to handle, the difference may also have been due in small part to disturbances during handling. The differences were not explained by the immediate responses to the overflights, which had been minimal for 10 weeks prior to processing. If severe bruising had occurred at 5-6 weeks of age (the time of first exposure), it is possible that some old bruises remained.

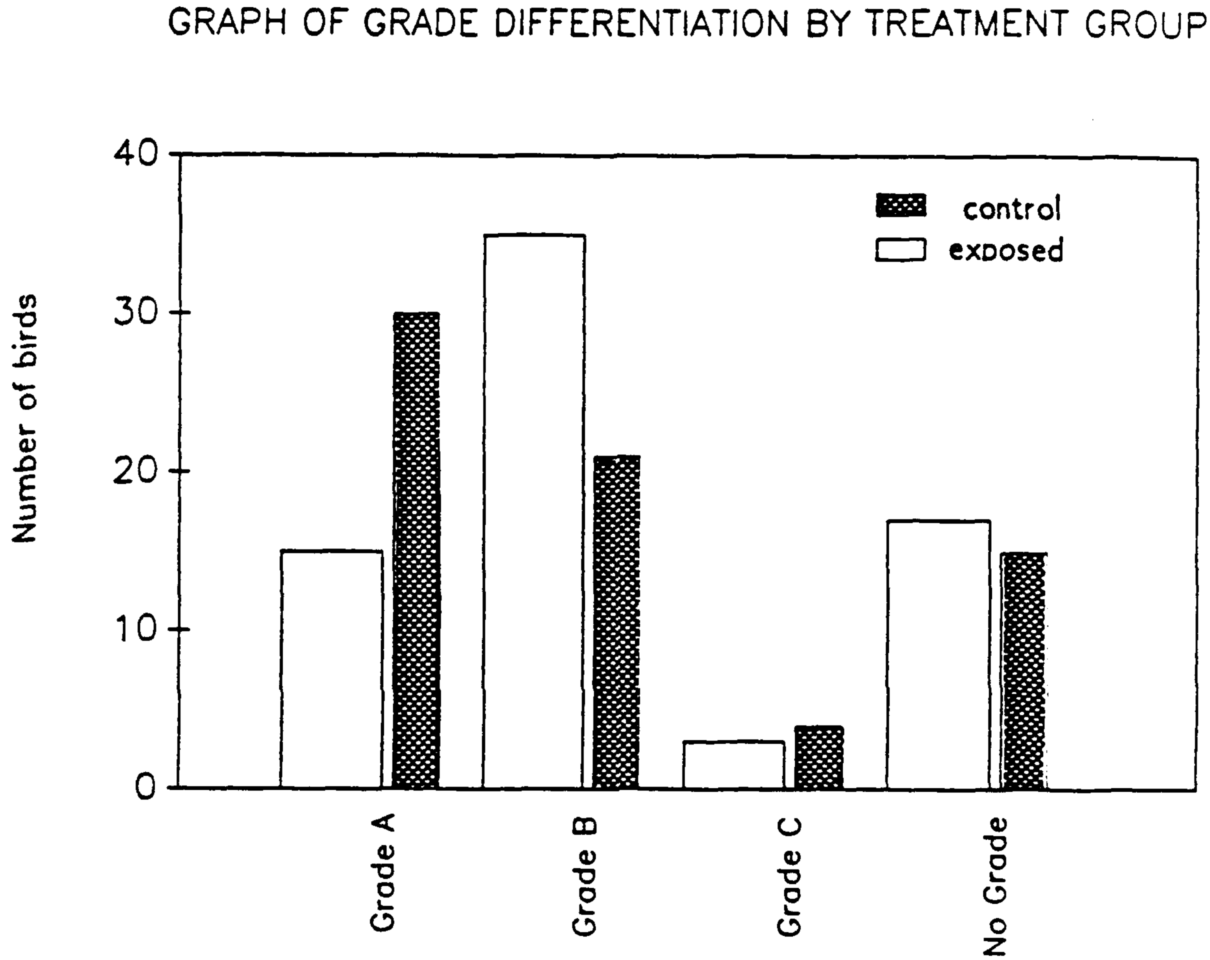


Figure 3-23. Results of Grading Turkeys from Both Exposed and Control Groups.

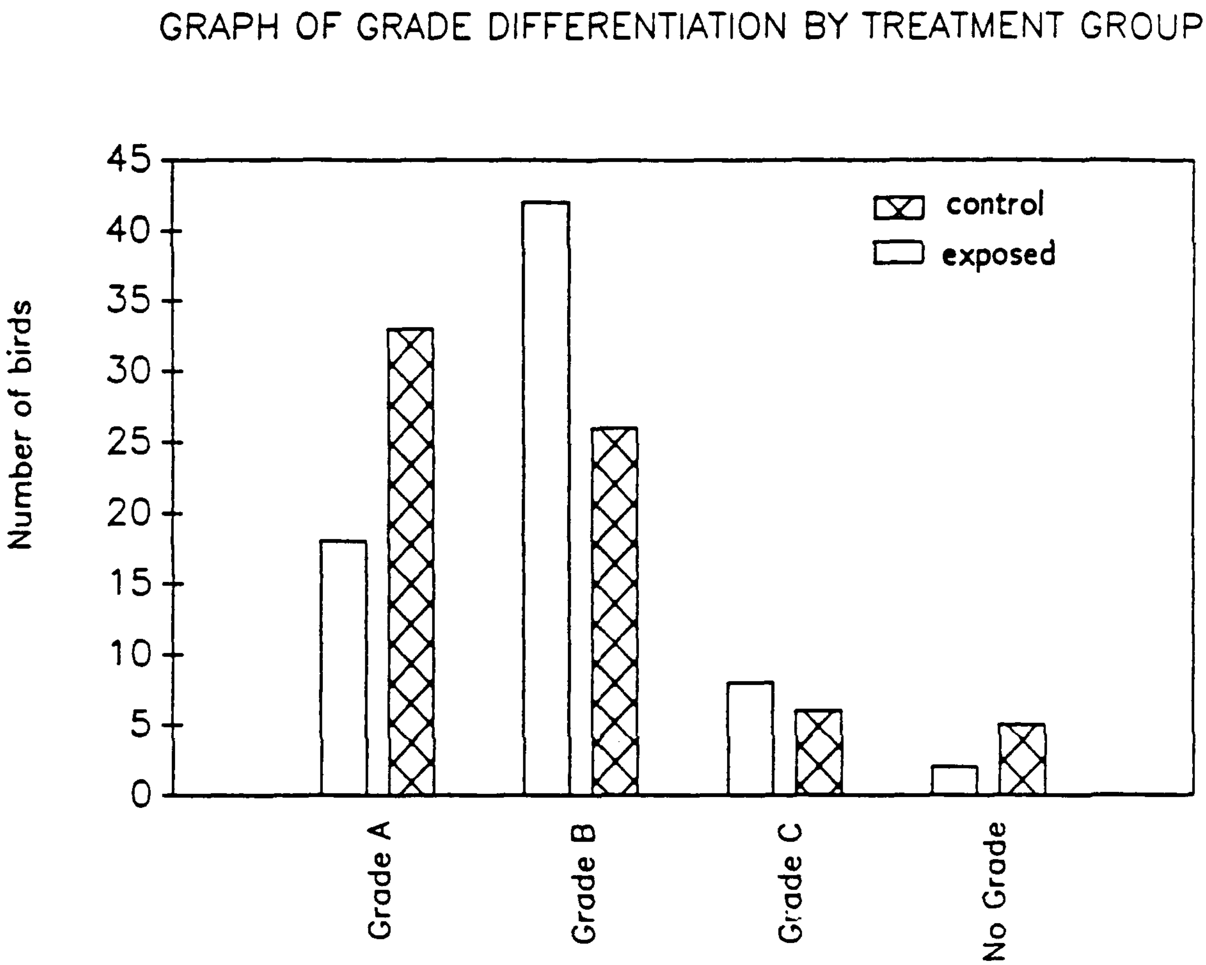


Figure 3-24. Results of Grading Turkeys from Both Exposed and Control Groups after Removing Data on Those That Had Been Weighed.

Table 3-3. Reasons for Downgrading Processed Turkeys from Both Control and Exposed Groups.

DOWN GRADING RESULTS FOR TASK 0022 SUBTASK 3

Original grade

Reason	sound	control
grade A	15	30
old bruise wing	13	8
old bruise thigh	9	6
old breast bruise	7	2
other old bruises	3	1
fresh bruise (slaughter)	7	5
disjointed limbs/breaks	3	1
discoloration	8	9
blisters/scabs	14	6
swollen legs	2	4
torn skin	1	3
crooked back	1	1

Numbers greater than 100% due to multiple reasons for down grades. 70 birds from each barn were graded. Birds could have been trimmed and regraded - listed under trimmed data on graph.

Original Grades	Sound	Control
A	15	30
B	35	21
C	3	4
no	17	15

After Trim estimated grades

A	18	33
B	42	26
C	8	6
no	2	5

No grade refers to birds with heavy damage or indications of severe injury. Only bad wing tips that can be easily removed allow a bird to become a grade A bird after being a no grade.

Once the weighed birds were removed from the analysis, the control group was within acceptable grade percentages. The national average is 72.4% A-grade (Warnick, 1988). Of the 35 birds from the control pen, 22 were grade A (68%), which is well within the national range (57.4% - 80.27%). The rate for the exposed pen was lower (18/35; 51%).

Table 3-4 shows the results of veterinary examinations of the birds at culling. A relatively large number of livers from the control group were condemned due to excess bile. These and examinations of the live birds suggested that a low-grade or subclinical bacterial or viral infection was present in the control group.

3.3.6 Results of survey study

The survey questionnaire was distributed by Mr. John Voris (Cooperative Extension Turkey Specialist, UCD) at the 9 May 1990 meeting of the California Turkey Forum. This is the largest monthly meeting of turkey producers in California. Detailed responses to the surveys are given in Appendix D. Thirteen of the 36 attendants at the meeting voluntarily answered the survey questions. Some expressed concern that the survey had to do with animal rights, and refused response.

The responses were coded to protect individual identity, and were summarized. All the respondents had experiences with stampeding and piling. However, since the respondents do not represent a random sample of turkey growers, this should not be taken as an indication that all growers have problems with piling and crowding. These results cannot be used to estimate incidence. They can be used to show that piling and crowding is not uncommon (at least 10 of the 36 growers at the Forum had at least one experience with crowding and piling).

Of the 10 respondents having experience with dangerous piling and crowding, four did not estimate the rate, three had experienced it often and six had experienced it five times or less. Follow-up calls yielded the following detailed information from one grower: In 10 years of raising turkeys for several companies, he had seen crowding and piling in both brooder and growout houses. The problem generally occurred from 1800-0600 hrs (during off hours), and mortalities ranged from a few individuals to 1-200. In general, losses were due to leg problems or broken wings. The stimuli that produced this effect were predators (dogs and coyotes), thieves, feed delivery trucks, lights shining

Table 3-4. Results of Pathology Reports for All Birds that Died during the Experiments.

REASONS FOR VETERINARY COMMENT OR CULL AT PROCESSING TASK 0022 SUBTASK 3

Reason	Sound	Control
no cull	56	26
congested lungs	4	5
hemorrhagic lungs	2	1
abnormal lungs	2	0
mottled liver	1	6
pale liver	4	8
liver condemn	1	15
viscera condemn	0	9

Veterinary comments refer to comments made by Dr. Kim Joyner, our consulting veterinarian. The only data that are important to economic results are the condemnations made by the local PMI (poultry Meat Inspector). She condemned livers for evidence of excess bile (green spots) and the viscera if there was irregularities in any other organs aside from the liver. Dr. Joyner is looking into reasons for green livers but postulated that it was probably feed (unlikely since all birds received the same feeds), viral or bacterial infections. She will report to us this week.

suddenly into the building, feed belt noise in the dark, ventilation problems, cold, and panic when one bird had a cardiac arrest.

The questions answered by other growers indicated that panic could occur in any type of growing operation (in brooder houses, growout barns, breeder barns, and range pens). Piling in brooders was cited most often, but this should not be taken to mean that most incidents occur in brooder houses because the experience of the respondents may have been largely with brooder houses. Losses could occur during the daytime but were most common at night, when the birds cannot see. The available detailed information on a few losses are given in Table 3-5.

Losses and injuries were due to broken wings, legs, and hips, suffocation in pileups, and internal injuries (not specified). The most commonly-cited causes of piling were predators (10/13 responses), miscellaneous loud noises (feed belt noise; other unspecified noise; 6/10), weather (4/13), management practices (4/13), light aircraft (e.g., crop-duster, 3/13), bright lights turned on suddenly at night (2/13), and disease (2/13).

Although the survey was neither randomized nor comprehensive, several important observations can be made from the responses:

1) Turkeys may be more vulnerable to damage from crowding and piling at night than during the day.

2) Jet aircraft were not mentioned by any of the respondents as causes of panics, although light aircraft (crop dusters) were. These aircraft also were not a major cause of losses. The major causes (when specifics could be listed) were predators, weather, and management practices.

3) When the cause of crowding was known, mortalities due to single incidents (as opposed to storms, management problems) tended to be a small percentage of the total number of birds present or responding.

Table 3-5. Summary of Panics Observed by Poultry Growers. The numbers of observations are small and incomplete because most growers do not keep records on losses due to piling and stampeding.

Response Code	Number	Number Responding	Number Lost	Stimulus
vj	350	20-30	-	dogs
vj	8000	8000	6000	wind and rain storm just after introduction to range pen
vj	-	2000	500	single incident in a dark house; cause unknown
cp	-	-	0.2 to 0.4%	predator?
fr	-	20,000	100-200	dogs, crop duster, loud noise, hail storm on tin roof
cr	-	300	80-100	predator
sh	-	-	20-50	poor management
sr	-	1-55,000	1-500	predators, loud noises, storms, crop duster, medication, heat
fr	-	16,000 in two barns	700-750	birds with aspergillosis had heart attacks on hot evenings
gb	-	<500	-	predators, loud noise, lights at night

4) Factors that could predispose the birds to dangerous responses were disease and management practices. One interesting specific observation on medication as a cause arose during further investigation: Nitrofurazone administered to control coccidiosis and secondary bacterial infections apparently was the culprit. One producer described apparent intoxication when the drug was administered in the drinking water. Hypersensitivity was seen in other flocks given nitrofurazone. In the latter group, a sudden change, such as a wild bird flying outside the barn, could cause the turkeys to stampede (the consequences were not mentioned).

3.4 Experiment 4: Independent Analysis of Videotaped Behaviors of Turkey Poults Chronically Exposed to Worst-Case Aircraft Noise

The videotapes did not yield as much information as we had hoped because the turkeys tended to aggregate in large groups directly under the camera post and were out of view when resting as a result. We were able to reliably measure the numbers of birds walking around at any moment, the number out of view, and the numbers at the feeding trough (presumably feeding). We were also able to collect running bouts, fights, and displacements in one-minute counts. Feather ruffling (an aggressive behavior) and preening were often difficult to resolve and could not be measured reliably.

The analysis was broken into two parts--analysis of behaviors on days with no experiments (three samples taken in the morning, noontime, and evening), and analysis of behaviors on days with experiments (samples at the same times). Twenty-three days with no experiments and 45 days with experiments were sampled. The results of the analysis are given in Figures 3-25 and 3-26.

Agonistic behaviors (fights and displacements) and running bouts were measured in 1-minute counts for 15 minutes. Scans of numbers of birds walking and feeding were collected every minute during the same sampling period.

All analyses were made with the SYSTAT system for statistics (Wilkinson, 1984) using non-parametric tests (the distributions of counts were heavily skewed and did not conform to the presumptions of ANOVA).

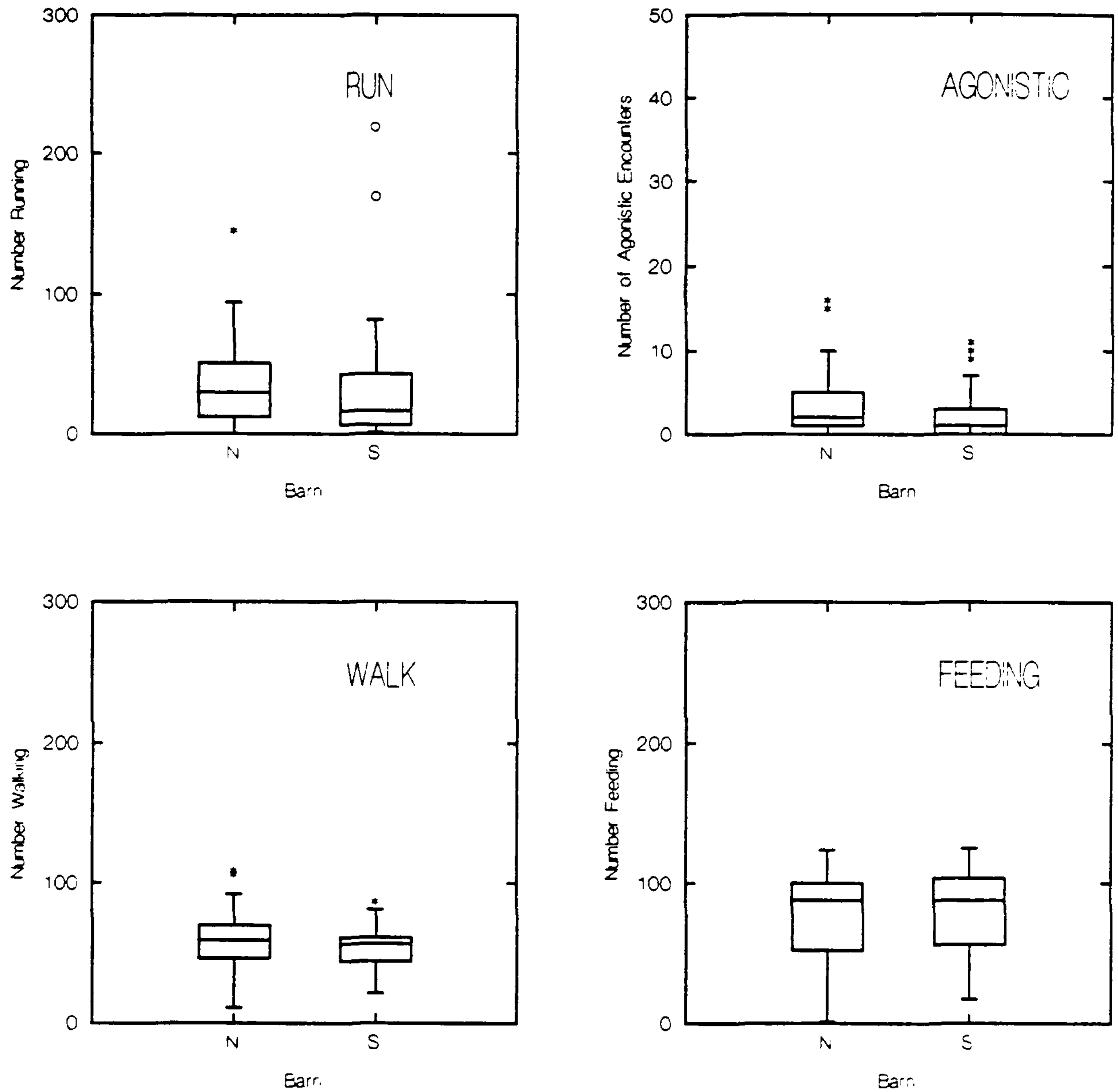


Figure 3-25. Comparison of Behaviors in Experimental (N) and Control (S) Barns on Days When No Experiments Were Conducted. Differences between the two barns were not significant. The center bar in these box plots is the median, the box marks the first quartile boundary, and the whisker marks the second. Outliers are marked with asterisks and circles.

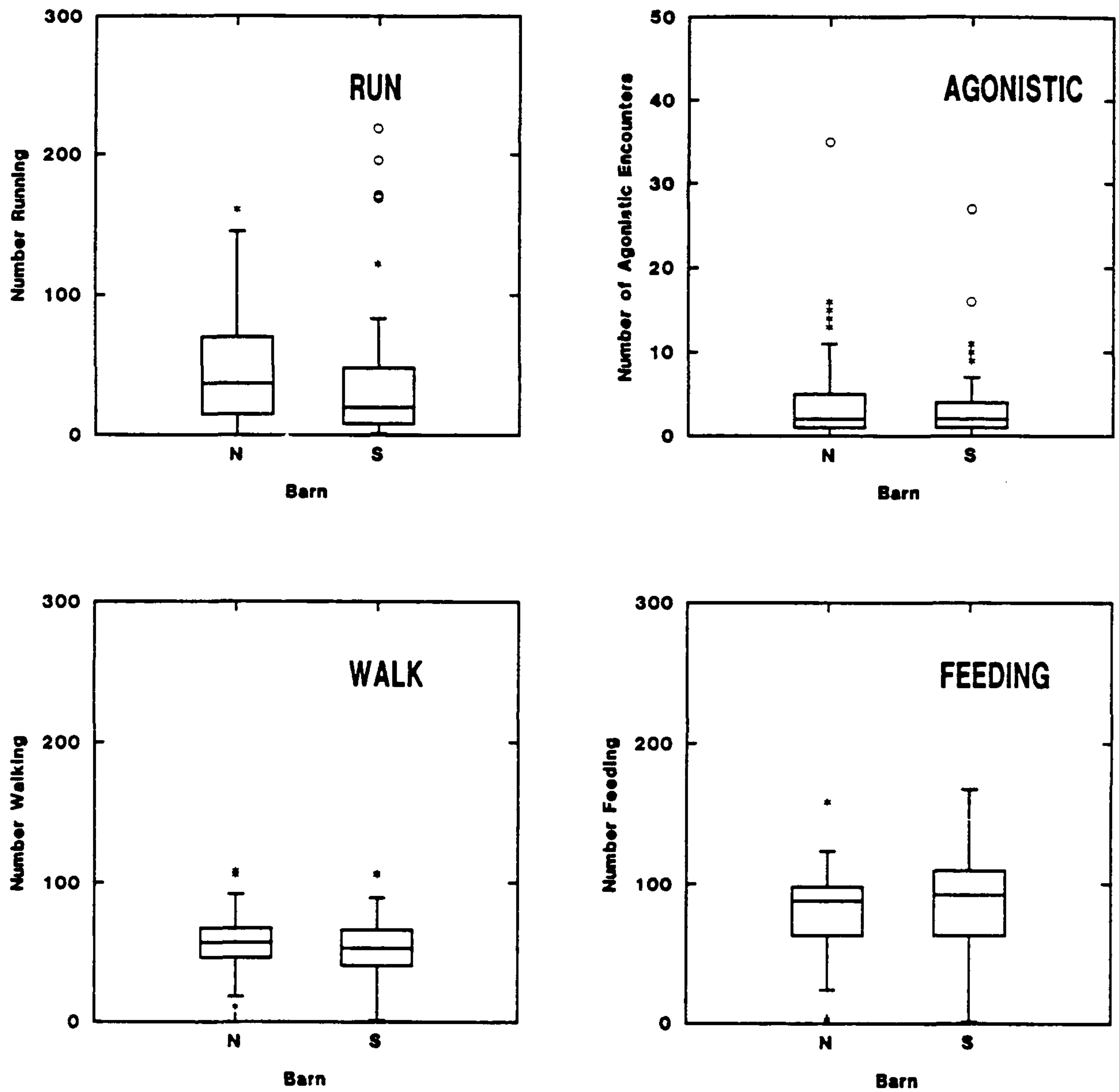


Figure 3-26. Comparison of Behaviors in Experimental (N) and Control (S) barns on Days When Experiments Were Conducted. Differences between the two barns were not significant. The center bar in those box plots is the median, the box marks the first quartile boundary, and the whisker marks the second. Outliers are marked with asterisks and circles.

Based on the 1-minute samples and pooling both experimental and nonexperimental days, the turkeys in the experimental barn were slightly more active than those in the control barn. Birds in the experimental barn ran significantly more often than their control barn counterparts (Kruskal-Wallis one-way ANOVA, $P<0.0001$) at all times of day. They were present at the feeder less often ($P<0.0001$), and were inactive less often ($P<.001$), although the latter measure was difficult to interpret because most inactive birds were out of camera view. There was a marginal difference in the numbers of birds walking in each scan ($P<.089$).

Unfortunately, many of the 1-minute counts contained zero behaviors. A large proportion of zero counts can bias the results of the statistical tests (Snedecor and Cochran, 1980). Thus, we decided to pool the 1-minute counts into 15-minute counts. Although such pooling reduces the power of the statistical test due to reduced sample size, it removed the bias due to large numbers of zero values. Figures 3-24 and 3-25 show the pooled counts. Based on this modified analysis, the differences between control and experimental groups were the result of statistical bias. For data collected on days with no experiments (Fig. 3-24) there were no differences between counts for each barn (running - $P < 0.521$; agonistic encounters - $P = 0.205$; feeding - $P = 0.593$; walking - $P = 0.586$). For data collected on days with experiments (Fig. 3-25) there were no differences either (running - $P = 0.160$; agonistic encounters - $P = 0.674$; feeding - $P = 0.154$; walking - $P = 0.510$).

Even if there are marginal differences in activity, they are based on the mean or median. Median counts of running bouts differed by 2-3 bouts only. The distribution of counts in the experimental barn was much broader than that in the control barn, however, with much greater numbers of high counts. This indicates that the experimental birds ran around proportionately more when they were active.

Observers noted a greater number of agonistic encounters in the experimental versus the control barn, resulting in higher numbers of picking incidents. As far as can be determined from the videotapes, these differences are the result of the generally higher levels of activity (if the birds were asleep more they also fought less.) However, subtle displays, such as feather ruffling, could not be detected on videotape, and many incidents of picking are likely to have occurred off-camera.

Several qualitative observations also supported the notion that birds in the experimental barn exchanged more agonistic behaviors. First, the experimental turkeys were more difficult to catch and handle than the control birds, an observation made both by UCD researchers and handlers from the processing plant. Second, observers noted that the incidence of fights and displacements in the exposed barn did not decline as it should have after dominance hierarchies were established (usually 4-6 days after introduction).

3.5 Experiment 5: Analysis of Data for Inclusion in a Model for Aircraft Noise Effects on Turkeys

3.5.1 Relation between noise dosage and crowding responses of naive turkeys

Two important results of these experiments will be included in the existing model for poultry in ASAN. First, **the crowding and piling response habituates very quickly to aircraft noise.** A single exposure of birds known to be naive extinguished the response completely in these experiments, even in the face of overheating, disturbance due to storms, and other stresses that have been purported to aggravate responses to aircraft noise. Latencies to normal activity are reduced by at least 50% after the first 1-2 exposures. Second, **the response may be extinguished by exposure to a stimulus of lesser intensity.** The 50 poults in the second series of tests in Experiment 1 were exposed to a habituating stimulus of 85 dB. These birds did not crowd or pile to the same stimulus that later aroused crowding and piling in naive birds. This means that birds exposed to distant overflights respond much less strongly than those that have no previous experience.

The previous experiments with naive birds (Stadelman, 1958a; Von Rhein, 1983) yielded results similar to those of Experiments 1-3. Stadelman exposed 2,400 naive 31-day-old broilers to jet noise with an amplitude of 115 dB (weighting unspecified), inducing crowding, piling and one death. This response was extinguished after the first exposure. Von Rhein exposed 404 42-day-old broilers to 12 F-4 overflights with sound levels over 100 dB (the initial exposure was to a sound level of 110.5 dB) without eliciting responses. He exposed 403 5-day-old broilers to the same stimulus and aroused piling responses for three exposures. He exposed adult hens to the same stimulus without arousing crowding and piling. These results suggest a gradual reduction in responsiveness with age. None of Von Rhein's chicks died.

In combination with the three series of experiments conducted here, published observations suggest a rough model for the naive response. It parallels the more detailed model that can be developed based on latency of response in habituated birds. High amplitude noise (>90-100 dB) can arouse crowding and piling. Low-amplitude noise does not. This response is extinguished within 1-3 exposures, and certainly within one exposure in birds older than 1 month. Previous disturbance (e.g., transport) reduces the chances of panic. The threshold of response is not specified exactly, but is somewhere between 85-100 dB. Based on lesser behavioral responses, the threshold is 95-100 dB. Below this threshold crowding does not occur. Above the threshold, crowding is likely to occur. The experimental evidence to date does not allow inference of the rate directly, but piling occurred in three out of four experiments with birds over a week old in Von Rhein's study. In order to be conservative, the rate of crowding will be assumed to be 100% above 100 dB.

The function in ASAN that describes probability of naive response reflects these data well, as long as the sound exposure level and not the sound level is used as a predictor (duration of the stimulus has an effect, based on the results of Experiments 1-3.) Onset rate need not be included as a factor. The current estimated function for the dose-response relation between sound level and probability of crowding (Reddingius and Bowles, 1990) is consistent with the new data as long as sound exposure level is used.

The habituation functions must be altered, however. First, the habituation rate appears to be more independent of sound level than believed, since the birds habituated as rapidly to sounds with sound levels of 85 dB as to sounds of >100 dB. Second, the decline in response is much more rapid than that predicted from neurophysiological responses, not unexpectedly. Thus, the model as currently implemented is too conservative. The decline in response is equally rapid to actual overflight noise as to simulated aircraft noise, so no correction needs to be introduced for visible aircraft.

We estimated the parameters of the habituation function given in Reddingius and Bowles (1990) from the responses to the 85 dB stimulus (#34; see Table 2-3) in Experiment 1 and to the 115 dB stimulus (#6; Experiment 3). Equation (1) describes the relation.

$$P = exp\ (-0.5 * ((n - 1) / \alpha)^2) \tag{1}$$

The parameters -0.5 and α determine the rate of habituation. Based on the data in Experiments 1 and 2, the values should be -0.15 and -0.658 for the 85 dB stimulus and -0.15 and -0.317 for the 115 dB stimulus. Both functions predict a zero probability of response within five exposures.

The distribution of losses after birds pile or stampede cannot be inferred from the single incident of crowding in this study. However, single incident losses reported by the respondents of the survey ranged from a few percent to about 30% of flocks exposed to single incidents, a reasonable estimate of the range of worst possible losses expected. Further NSBIT monitoring efforts in cooperation with poultry growers should elicit enough incidents to determine the distribution of losses in actual practice, something that cannot be measured by any ethical experiment. Most incidents of crowding probably result in no effect, since most experienced growers had only a handful of incidents to report. This is consistent with the small incidence of claims against the USAF.

Because of flock cohesion, if a few birds panic, many of the birds in a flock are likely to crowd and pile. The model currently estimates a proportion of birds responding. It is better to assume they all respond based on the observations here and in Von Rhein (1983).

3.5.2 Responses to chronic exposure

No model could be developed for the effects of chronic exposure before this study, as experiments had been poorly designed to detect subtle effects. These experiments were sufficiently sensitive, and could be used to make predictions of economic effect. These will be broken down into effects on growth, effects on feed consumption, effects on mortality, and effects on carcass quality. Only the last was substantial enough to warrant any sort of model.

3.5.2.1 *Effects on growth*

The poults in these experiments were exposed to 10 weeks of the worst possible exposure (approximately 17 incidents per week with sound levels over the 100 dB threshold). In actual practice, this type of exposure is unlikely to occur because the complaints of the farmer would result in changes in the overflight routes. At the end of the experimental period, differences in growth

rates were still below the level of statistical detection and the birds all fledged at or above industry standard weights. Therefore, the economic impact on meat production is unlikely to be significant.

3.5.2.2 *Effects on feed consumption efficiency*

The feed conversion (intake-to-gain ratio) was very high for both experimental and control groups. The ratio was highest in the experimental barn at age 14 weeks, when a high level of picking was observed in the exposed groups. Five birds were culled due to picking that week. This is the result of increased activity in response to frequent disturbance, which results in wasted energy and probably more loss due to wastage as well. However, the differences were not statistically significant and represented a small loss. The difference was on the order of 7.3%, a worst-case estimate. Figure 3-19 shows that the difference in consumption did not become detectable until the birds had been exposed steadily for 6 weeks. This gives an estimate of the cumulative exposure required to produce the effect. We could construct a simple model based on cumulative measures of exposure (L_{eq}) to predict differences in feed consumption. Such an effort would not predict much loss, however.

3.5.2.3 *Losses of marketable hens*

A greater number of birds were lost due to picking in the exposed barn, both relative to the control barn and relative to industry standards. Rates of picking were not quantifiable over the course of the study, despite extensive analysis of the videotapes. In numeric terms, the total number of birds lost was small, less than the 10% normally anticipated in a commercial setting. The losses due to picking are important not for their economic significance, which was not large, but because cannibalism is an ugly problem that can spread throughout a flock. Because we do not know whether the picking in the exposed barn was higher due to noise exposure or due to a habit developed by a few birds, little can be done to predict picking at this point.

3.5.2.4 *Effects on carcass quality*

The initial crowding incident and chronic exposure resulted in detectable effects on the carcass quality of domestic turkeys, based on the results of Experiment 3. The effects were not predicted from previous experiments because none had examined either behavioral effects or effects

on carcass quality. The economic effect of the downgrading (60% relative loss after 10 weeks of worst-case exposure) depends on the type of turkey operation that was exposed, so any model that is developed should simply report the proportion of turkeys downgraded.

To get an idea of the economic effect, the market for turkey meat must be understood. At one time, all the turkeys raised in the United States went to the whole-body holiday market, which is strongly affected by downgrading. Today, most growers provide meat year-round for processed products. Some companies send their entire production, regardless of grade, through further processing. Thus, the company loses nothing even if its product is significantly downgraded. However, the growers are paid based on the grade of the processed turkeys, and may receive a lower price per pound (by $0.05 per lb) if their birds are graded below industry standards.

Some small producers also produce mainly specialty whole-body turkeys for the holiday market. They can only sell grade A birds on this market. Some of these producers can also process downgraded carcasses, and so do not lose anything as a result of downgrading. However, those that cater particularly to the whole-body market are vulnerable to significant economic impacts due to repeated exposure based on the results of Experiment 3. If these growers have to resell their downgraded processed birds to an outside market, the best price they can receive is the Canner Packed price as quoted in the Urner Barry's Price Current. For a recent holiday (Easter of 1990), the specialty whole-body producers in California received $1.00 per lb as opposed to the Canner price of $0.57 per lb. The worst-case 60% relative loss predicted by these experiments would have resulted in an overall economic loss of around 30%.

At present, we can only presume that the loss would be a linear function of cumulative exposure, since we still do not know the actual cause of the downgrades, and we have only one level of exposure to use in making the prediction. The losses must be explored further to determine the actual relation between behaviors and downgrading, and to determine the function that describes loss with cumulative exposure. We can speculate that exposures would have their greatest effect during the period after about 12 weeks of age, when losses to picking were greatest and when the feed intake-to-gain ratios increased rapidly.

4.0 DISCUSSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the results of these experiments, it is quite clear that the ASAN dose-response model for responses of naive poultry to overflight noise would benefit greatly from a monitoring program in areas heavily travelled by military aircraft. At present, it is impossible to replicate damages due to piling and crowding, even though such effects undoubtedly occur. It would be unethical and impractical to expose many large groups of naive turkeys to experimental overflights to induce damages, especially since flocks of over 55,000 birds are found in commercial practice, and such group sizes are clearly unwieldy from an experimental point of view. However, it is important to determine what sounds induce panic and how much experience with noise (including all sorts of distant aircraft) the turkeys need before they can no longer be considered naive. These things can be monitored only at farms.

The naivete of the birds is crucial in explaining large mortalities due to crushing and suffocation after exposure to low-altitude overflights. Based on the results of Experiment 1, initial habituation due to exposures to distant and non-disturbing aircraft can play an important role in determining whether birds pile and crowd dangerously.

As an example, this "pre-habituation" would explain why experiments conducted by the USAF in the vicinity of air bases (Manning, pers. comm.) do not give rise to mortalities at all. We have reviewed a videotape collected by the USAF at a commercial poultry growing operation in the vicinity of a large air base in Riverside County, CA. The several thousand 7-14 week-old turkeys at this operation had been exposed to regular but distant air traffic prior to this informal experiment. They were exposed to flat-weighted sound pressure levels of over 127 dB administered by visible aircraft at 300 feet AGL. Although they startled and ran short distances, no panic crowding or piling was observed. Operations near bases are likely to be previously exposed, but those at remote sites along MTRs are not, increasing the chances of significant damage at the remote sites.

The results of the survey study in this report show that stampeding and piling cause at least some losses in actual practice, but they do little to quantify the incidence or the distribution of losses when birds respond. Estimates of both stampeding and piling must be based on monitoring studies

at commercial turkey growing operations and on surveys of an unbiased sample of exposed and unexposed operations.

Based on the results of Experiment 2, actual aircraft overflights are probably perceived as different from simulations by poultry, but these differences do not give rise to a difference in response thresholds or habituation rates. This means that much of the necessary information on panic responses could be determined experimentally if ethical studies could be devised.

The results of Experiment 3 suggest that there are effects on carcass quality and mortality due to chronic exposure to the most disturbing stimuli. Such effects have not been detected previously, and we recommend that the experiment should be repeated without the growth-rate portion of the study, to reduce disturbance with improved video monitoring of behaviors to detect picking and other potential causes of bruising.

The results of Experiment 3 do put to rest the notion that exposure to low-altitude overflights, particularly single overflight incidents, can affect body weight in either turkeys or chickens. These results agree with every other study of infrequent intermittent exposure to noise (Stadelman, 1958a; Cottereau, 1972; Kagan, 1974; Von Rhein, 1983). Like effects on hatchability, effects on weight gain are not detectable experimentally and are probably not worth pursuing further. Even if the differences observed in Experiment 3 had been statistically detectable, they would have no commercially-important impact on growth.

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APPENDIX A

SUMMARIES OF NOISE EXPOSURE AT DIFFERENT AREAS IN THE EXPERIMENTAL ENCLOSURE FOR EACH STIMULUS

Table A-1. Summary of noise levels in turkey observation areas for aircraft sample No. 4.

ID#:4 AIRCRAFT TYPE: B-1B							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	100.0	112.8	110.8	100.0	114.5	113.3	± 2.00
2	96.0	108.8	106.8	96.0	110.5	109.3	± 2.00
3	91.0	103.8	101.8	91.0	105.5	104.3	± 3.00
4	87.0	99.8	97.8	87.0	101.5	100.3	± 1.00

Table A-2. Summary of noise levels in turkey observation areas for aircraft sample No. 6.

ID#:6 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	99.4	112.9	114.8	100.3	113.5	116.9	± 2.00
2	95.4	108.9	110.9	96.3	109.5	112.9	± 2.00
3	90.4	103.9	105.8	91.3	104.5	107.9	± 3.00
4	86.4	99.9	101.8	87.3	100.5	103.9	± 1.00

Table A-3. Summary of noise levels in turkey observation areas for aircraft sample No. 8.

ID#:8 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	99.6	112.8	111.4	97.1	112.7	112.6	± 2.00
2	95.6	108.8	107.4	93.1	108.7	108.6	± 2.00
3	90.6	103.8	102.4	88.1	103.7	103.6	± 3.00
4	86.6	99.8	98.4	84.1	99.7	99.6	± 1.00

Table A-4. Summary of noise levels in turkey observation areas for aircraft sample No. 10.

ID#:10 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	101.3	112.1	111.8	97.7	112.8	113.1	± 2.00
2	97.33	108.1	107.8	93.7	108.8	109.1	± 2.00
3	92.3	103.1	102.8	88.7	103.8	104.1	± 3.00
4	88.3	99.1	98.8	84.7	99.8	100.1	± 1.00

Table A-5. Summary of noise levels in turkey observation areas for aircraft sample No. 12.

ID#:12 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	102.1	113.0	108.8	98.5	113.0	110.0	± 2.00
2	98.13	109.0	104.8	94.5	109.0	106.0	± 2.00
3	93.1	104.0	99.8	89.5	104.0	101.0	± 3.00
4	89.1	100.0	95.8	85.5	100.0	97.0	± 1.00

Table A-6. Summary of noise levels in turkey observation areas for aircraft sample No. 14.

ID#:14 AIRCRAFT TYPE: KC-135							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	101.7	113.5	111.2	94.3	111.8	110.2	± 2.00
2	97.7	109.5	107.2	90.3	107.8	106.2	± 2.00
3	92.7	104.5	102.2	85.3	102.8	101.2	± 3.00
4	88.7	100.5	98.2	81.3	98.8	97.2	± 1.00

Table A-7. Summary of noise levels in turkey observation areas for aircraft sample No. 16.

ID#:16 AIRCRAFT TYPE: B-1B							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	100.6	112.4	111.0	97.5	113.6	113.3	± 2.00
2	96.6	108.4	107.0	93.5	109.6	109.3	± 2.00
3	91.6	103.4	102.0	88.5	104.6	104.3	± 3.00
4	87.6	99.4	98.0	84.5	100.6	100.3	± 1.00

Table A-8. Summary of noise levels in turkey observation areas for aircraft sample No. 18.

ID#:18 AIRCRAFT TYPE: B-1B							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	88.1	97.6	95.7	86.2	99.1	98.0	± 2.00
2	84.1	93.64	91.7	82.2	95.1	94.0	± 2.00
3	79.1	88.6	86.7	77.2	90.1	89.0	± 3.00
4	75.1	84.6	82.7	73.2	86.1	85.0	± 1.00

Table A-9. Summary of noise levels in turkey observation areas for aircraft sample No. 20.

ID#:20 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	87.6	98.0	99.7	86.4	98.5	101.8	± 2.00
2	83.6	94.0	95.7	82.4	94.5	97.8	± 2.00
3	78.6	89.0	90.7	77.4	89.5	92.8	± 3.00
4	74.6	85.0	86.7	73.4	85.5	88.8	± 1.00

Table A-10. Summary of noise levels in turkey observation areas for aircraft sample No. 22.

ID#:22 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	89.5	97.8	96.4	82.6	97.6	97.6	± 2.00
2	85.5	93.8	92.4	78.6	93.6	93.62	± 2.00
3	80.5	88.8	87.4	73.6	88.6	88.6	± 3.00
4	76.5	84.8	83.4	69.6	84.6	84.6	± 1.00

Table A-11. Summary of noise levels in turkey observation areas for aircraft sample No. 24.

ID#:24 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	89.6	97.0	96.7	84.2	97.5	98.0	± 2.00
2	85.6	93.0	92.7	80.2	93.5	94.0	± 2.00
3	80.6	88.0	87.7	75.2	88.5	89.0	± 3.00
4	76.6	84.0	83.7	71.2	84.5	85.0	± 1.00

Table A-12. Summary of noise levels in turkey observation areas for aircraft sample No. 26.

ID#:26 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	90.4	97.9	93.8	86.9	98.5	94.8	± 2.00
2	86.4	93.9	89.8	82.9	94.5	90.8	± 2.00
3	81.4	88.9	84.8	77.9	89.5	85.8	± 3.00
4	77.4	84.9	80.8	73.9	85.5	81.8	± 1.00

Table A-13. Summary of noise levels in turkey observation areas for aircraft sample No. 28.

ID#:28 AIRCRAFT TYPE: KC-135							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dbC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	89.0	98.3	96.0	85.6	96.3	95.0	± 2.00
2	85.0	94.3	92.0	81.6	92.3	91.0	± 2.00
3	80.0	89.3	87.0	76.6	87.3	86.0	± 3.00
4	76.0	85.3	83.0	72.6	83.3	82.0	± 1.00

Table A-14. Summary of noise levels in turkey observation areas for aircraft sample No. 30.

ID#:30 AIRCRAFT TYPE: B-1B							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	88.2	97.2	95.8	86.3	98.5	98.1	± 2.00
2	84.2	93.2	91.8	82.3	94.5	94.1	± 2.00
3	79.2	88.2	86.8	77.3	89.5	89.1	± 3.00
4	75.2	84.2	82.8	73.3	85.5	85.1	± 1.00

Table A-15. Summary of noise levels in turkey observation areas for aircraft sample No. 32.

ID#:32 AIRCRAFT TYPE: B-1B							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	77.2	82.8	80.7	75.5	84.3	83.5	± 2.00
2	73.2	78.8	76.7	71.5	80.3	79.5	± 2.00
3	68.2	73.8	71.7	66.5	75.3	74.5	± 3.00
4	64.2	69.8	67.7	62.5	71.3	70.5	± 1.00

Table A-16. Summary of noise levels in turkey observation areas for aircraft sample No. 34.

ID#:34 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	76.7	83.0	84.7	74.5	83.6	87.6	± 2.00
2	72.7	79.0	80.7	70.5	79.6	83.6	± 2.00
3	67.7	74.0	75.7	65.5	74.6	78.6	± 3.00
4	63.7	70.0	71.7	61.5	70.6	74.6	± 1.00

Table A-17. Summary of noise levels in turkey observation areas for aircraft sample No. 36.

ID#:36 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	77.7	82.9	81.6	76.1	82.8	83.0	± 2.00
2	73.7	78.9	77.6	72.1	78.8	79.0	± 2.00
3	68.7	73.9	72.6	67.1	73.8	74.0	± 3.00
4	64.7	69.9	68.6	63.1	69.8	70.0	± 1.00

Table A-18. Summary of noise levels in turkey observation areas for aircraft sample No. 38.

ID#:38 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	77.2	82.4	81.8	76.4	82.8	83.5	± 2.00
2	73.2	78.4	77.8	72.4	78.8	79.5	± 2.00
3	68.2	73.4	72.8	67.4	73.8	74.5	± 3.00
4	64.2	69.4	68.8	63.4	69.8	70.5	± 1.00

Table A-19. Summary of noise levels in turkey observation areas for aircraft sample No. 40.

ID#:40 AIRCRAFT TYPE: F-4D							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	79.0	83.0	78.9	77.1	83.9	80.3	± 2.00
2	75.0	79.0	74.9	73.1	79.9	76.3	± 2.00
3	70.0	74.0	69.9	68.1	74.9	71.3	± 3.00
4	66.0	70.0	65.9	64.1	70.9	67.3	± 1.00

Table A-20. Summary of noise levels in turkey observation areas for aircraft sample No. 42.

ID#:42 AIRCRAFT TYPE: KC-135							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	77.3	83.4	81.3	71.2	81.5	82.6	± 2.00
2	73.3	79.4	77.3	67.2	77.5	78.6	± 2.00
3	68.3	74.4	72.3	62.2	72.5	73.6	± 3.00
4	64.3	70.4	68.3	58.2	68.5	69.6	± 1.00

Table A-21. Summary of noise levels in turkey observation areas for aircraft sample No. 44.

ID#:44 AIRCRAFT TYPE: B-1B							
Area	A-Weighted Noise Level Descriptors (dBA)			C-Weighted Noise Level Descriptors (dBC)			Noise Level Range in Area (dB)
	LEQ	MAX	SEL	LEQ	MAX	SEL	
1	77.8	82.4	80.9	74.8	83.7	83.8	± 2.00
2	73.8	78.4	76.9	70.8	79.7	79.8	± 2.00
3	68.8	73.4	71.9	65.8	74.7	74.8	± 3.00
4	64.8	69.4	67.9	61.8	70.7	70.8	± 1.00

APPENDIX B

DETAILED SUMMARY OF EXPERIMENTAL EXPOSURES ADMINISTERED IN EXPERIMENT 3

Date	Time	Stimulus ID	Reaction
3/29	1202	6	panic
	1225	6	alert
3/30	1227	6	little
	1324	8	little
	1747	6	little
3/31	0844	14	darts, running
	0914	6	little
	0919	8	little
	1018	6	dart, avoid
4/2	1048	6	dart, avoid
	1115	6	little
	1437	4	little
	1446	6	little
4/4	0730	6	dart, avoid
	0924	14	little
	1124	6	little
	1347	6	stand
	1401	6	little
4/5	0757	4	stand
	0820	6	dart
	0920	6	dart
	1004	8	alert
	1016	6	alarm calls (already alert)
4/7	0947	6	little
	1004	14	little
	1040	6	little
	1050	6	little
4/9	1102	8	truck
	1112	6	dart
	1318	6	little
	1342	4	little
	1439	6	3 alarm calls
	1446	8	alert
	1500	6	picking

4/11	1600	6	alert
(beak trim)	1622	8	little
(heat wave)	1430	6	little
4/12	0751	6	none
	0857	4	none
4/14	1031	6	little
	1035	8	little
	1046	6	little
4/16	1110	6	1 alarm call
	1124	14	3 dart
	1149	6	2 alert
	1437	6	little
	1500	4	none
4/17	0902	6	little
	0946	6	darts
	1004	8	little
4/18	0858	6	none
	0948	14	little
	1029	6	none
	1418	6	none
	1436	8	little
4/20	1457	6	little
	1509	14	3 alarm calls
	1637	6	little
	1501	6	little
	1800	4	little
4/22	1808	6	little
	1812	8	none
	0933	6	little
	0944	14	little
	1021	6	little
	1356	6	little
(windy)	1416	6	dart, flap
4/25	0843	8	alert
	0941	6	alert

	1016	6	alert
	1055	4	little
	1100	6	alert
4/26	1115	6	little
(hot)	1128	6	running in 40 bird pen (45 sec) running in 20 bird pen
(>90°F)	1228	8	little
	1242	6	stand
	1539	6	little
4/28	0841	14	2 alarm calls
	0908	6	little
	0913	6	4 dart
	1010	6	none
4/30	1106	8	little
(roof lost in wind storm)	1128	6	little
	1504	6	little
	1514	6	none
5/2	0906	4	little
	0923	6	little
	0953	6	none
(weighed)	1023	6	little
	1131	8	little
5/3	0800	4	2 darts
	0823	6	little
	0908	6	little
	0937	4	1 alarm call
(95°F)	1008	6	none
5/5	1010	6	little
	1027	14	little
	1104	6	little
(97°F)	1114	6	little
5/7	1117	6	little
	1129	4	little
	1329	6	little
	1344	6	3 alarm calls
	1445	6	little

	1452	8	none
5/9	0854	6	darts
	1106	8	little
	1148	6	none
	1327	6	none
5/10	0934	14	none
	1042	6	none
	1048	6	none
5/12	0951	6	little
	0955	8	2 darts
	1025	6	none
5/14	1050	6	2 alarm calls
(sheep in barn)	1105	14	little
	1136	6	1 alarm call, many alert
	1511	6	none
	1542	6	none
5/15	0908	6	little
	0953	4	3 darts
	1012	6	none
5/16	0813	6	none
	0820	8	little
	0830	6	none
5/18	1435	6	little
	1455	8	2 alarm calls, alert
	1635	6	little
	1645	6	1 alarm call
	1748	6	little
	1800	4	none
5/20	1815	6	alert
5/21	0912	14	alert
	0922	6	little
	1016	6	little
	1430	6	none
	1438	4	little
	1516	6	none

5/22	0914	6	none
	0932	8	little
	1007	6	little
5/23	0821	6	little
	1021	14	none
5/24	1216	6	none
	1221	4	none
	1233	6	none
5/26	0900	6	darts
(rainy, windy)	0905	14	alert
	0932	6	alert
	1030	6	little
	1040	4	little
5/28	1055	6	little
	1103	6	little
	1117	8	little
	1148	6	alert
	1222	6	little
	1232	14	alert
5/30	0810	6	none
	0815	6	little
	0825	6	2 alarm calls
	1049	4	1 alarm call
5/31	0822	6	little
	0847	6	1 alarm call, some aggregation
	0948	6	little
	1010	4	none
6/2	1026	6	alerts
	1124	6	little
	1045	6	little
6/4	1114	8	little

APPENDIX C

FORMULA OF RATION GIVEN TO TURKEYS

FEEDS FOR ALL NEEDS

LINCOLN

CALIFORNIA FEED TAX PAID

NET WEIGHT 8 POUNDS

LINCOLN BRAND

TURKEY GROWER CRUMBLES 24

Manufactured By

WALTER JANSEN & SON, INC.

LINCOLN — CALIFORNIA

GUARANTEED ANANLYSIS

Crude Protein, not less than	24.00%
Crude Fat, not less than	2.50%
Crude Fibre, not more than	7.00%
Ash, not more than	10.00%
Added Minerals, not more than	2.00%

INGREDIENTS Processed Whole Grains, Meat and Bone Meal, Soybean Meal, Cottonseed Meal, Dehi Alfalfa Meal, Shell Flour, Bentonite, Whey, Salt, Rice Mill By-products, Calcium Carbonate, Choline, Wheat Middlings, Ethoxyquin, Vitamin B-12, Niacin, D-alpha-Tocopheryl Acetate (Source of Vitamin E), Riboflavin Supplement, Vitamin A Palmitate, DL Calcium Pantothenate, D-Activated Animal Sterol (Source of Vitamin D-3), Folic Acid, Menadione Sodium Bisulfite Complex (Source of Vitamin K), Manganese Sulphate, Ferrous Carbonate, Zinc Oxide, Copper Oxide, Calcium Iodate, Cobalt Carbonate, Manganous Oxide.

APPENDIX D

GRADING SYSTEM USED TO EVALUATE CARCASS QUALITY

SUMMARY OF SPECIFICATIONS OF QUALITY FOR INDIVIDUAL CARCASSES OF READY-TO-COOK POULTRY AND PARTS THEREFROM

(Minimum Requirements and Maximum Defects Permitted)

FACTOR		A QUALITY			B QUALITY			C QUALITY
CONFORMATION		Normal			Moderate deformities			Abnormal
Breastbone		Slight curve or dent			Moderately dented, curved or crooked			Seriously curved or crooked
Back		Normal (except slight curve)			Moderately crooked			Seriously crooked
Legs and Wings		Normal			Moderately misshapen			Misshapen
FLESHING		Well fleshed, moderately long, deep and rounded breast			Moderately fleshed, considering kind, class and part			Poorly fleshed
FAT COVERING		Well covered—especially between heavy feather tracts on breast and considering kind, class and part			Sufficient fat on breast and legs to prevent distinct appearance of flesh through the skin			Lacking in fat covering over all parts of carcass
PINFEATHERS								
Nonprotruding pins and hair		Free			Few scattered			Scattering
Protruding pins		Free			Free			Free
EXPOSED FLESH[1]								
Carcass Weight		*Breast and Legs*	*Elsewhere*	*Part*	*Breast and Legs[2]*	*Elsewhere[2]*	*Part*	
Minimum	*Maximum*							No Limit
None	1½ lbs	None	¾"	Slight trim on edge	¾"	1½"	Moderate amount of the flesh normally covered	
Over 1½ lbs	6 lbs	None	1½"		1½"	3"		
Over 6 lbs	16 lbs	None	2"		2"	4"		
Over 16 lbs	None	None	3"		3"	5"		
DISCOLORATIONS[3]								
None	1½ lbs	¾"	1"	¼"	1"	2"	¼"	No Limit
Over 1½ lbs	6 lbs	1"	2"	½"	2"	3"	1"	
Over 6 lbs	16 lbs	1½"	2½"	½"	2½"	4"	1½"	
Over 16 lbs	None	2"	3"	½"	3"	5"	1½"	
Disjointed bones		1			2 disjointed and no broken or 1 disjointed and 1 nonprotruding broken			No limit
Broken bones		None						No limit
Missing parts		Wing tips and tail[5]			Wing tips, 2nd wing joint and tail. Back area not wider than base of tail and extending half way between base of tail and hip joints			Wing tips, wings and tail. Back area not wider than base of tail extending to area between hip joints
FREEZING DEFECTS (When consumer packaged)		Slight darkening over the back and drumsticks. Few small ⅛" pockmarks for poultry weighing 6 lbs or less and ¼" pockmarks for poultry weighing more than 6 lbs. Occasional small areas showing layer of clear or pinkish ice			Moderate dried areas not in excess of ½" in diameter. May lack brightness. Moderate areas showing layer of clear, pinkish or reddish colored ice			Numerous pockmarks and large dried areas

[1]Total aggregate area of flesh exposed by all cuts and tears and missing skin, not exceeding the area of a circle of the diameters shown.

[2]A carcass meeting the requirements of A quality for fleshing may be trimmed to remove skin and flesh defects, provided that no more than one-third of the flesh is exposed on any part and the meat yield is not appreciably affected.

[3]Flesh bruises and discolorations such as blue back are not permitted on breast and legs of A quality birds. Not more than one-half of total aggregate area of discolorations may be due to flesh bruises or blue back (when permitted), and skin bruises in any combination.

[4]No limit on size and number of areas of discoloration and flesh bruises if such areas do not render any part of the carcass unfit for food.

[5]In ducks and geese, the parts of the wing beyond the second joint may be removed, if removed at the joint and both wings are so treated.

APPENDIX E

QUESTIONNAIRE ADMINISTERED DURING SURVEY STUDY

Questionnaire

Name ______________________________

Mailing Address ______________________________

____

Business Telephone ( ) ____________

Have you ever had turkeys stampede or pile? _____ Yes _____ No
If YES, how often: ____________

If YES, please continue on with this questionnaire. The remaining questions refer to the stampede/pile situation:

Describe the operation: _______ Brooder House

______ Grow-Out Barn _____ Breeder Barn _______ Range Pen

Did it happen during the _____ day or _____ evening?

Approximately how many birds were involved? ____________

Was there mortality? _____ No _____ Yes If YES, how many birds were killed? ____________

Were birds hurt, but not killed? ____ No _____ Yes If YES, how many birds were injured and what were the nature of the injuries?

____

____

Was the cause of the stampede/pile determined? ____ No ____Yes

If YES, what did you determine the cause to be?
a) predator ____
b) loud noise ____
c) other, specify

____

____

____

____

Thank you for taking the time to answer this questionnaire
-Francine A. Bradley, Ph.D., Area Poultry Farm Advisor/Northern California
(916) 752-6316

APPENDIX F

RESULTS OF MEASUREMENTS OF OVERFLIGHT NOISE (EXPERIMENT 2)

Event #	Sound Source	CPA (?) Altitude	Date	Time	Measurement Source	dB SEL A-Weighted	dB Max A-Weighted	dB Max C-Weighted	dB SEL Flat-Weighted	dB Max Flat-Weighted	Photo #	Notes	
A	1 Jet	?	1-Apr	11:38	162 SEL	96.8	96.7						
A	"	"	"	"	"	74	75.4						
A	"	"	"	"	"	76.1	74.8						
B	2 Jets	> 1000'	2-Apr	10:43	DAT				81.2 (Tail only)				
1	2 Jets - F Type	2-300'	2-Apr	12:56	GenRad 1982			131.9 dB (Peak)					
1	"	"	"	"	B&K 2230	113.9	114.1						
1	"	"	"	"	162 SEL	98.8	95.2					1st Jet	
1	"	"	"	"	"	83	82.2						
1	"	"	"	"	"	113.6	112.2					2nd Jet	
2	2 Jets - F Type	4-500'	2-Apr	14:40	DAT				87.7 (Tail only)				
2	"	"	"	"	B&K 2230	101.3	107.3						
2	"	"	"	"	162 SEL	78.5	83.6					1st Jet	
2	"	"	"	"	"	99.7	96.2					2nd Jet	
3	4 Jets - F Type	3-500'	3-Apr	8:35	GenRad 1982			107.2			6-10 (1)		
3	"	"	"	"	B&K 2230	109.1	101.7				9or10 CPA		
3	"	"	"	"	162 SEL	98	91.9					1st Jet	
3	"	"	"	"	"	87.6	84.6					2nd Jet	
3	"	"	"	"	"	109.4	103.5					3rd Jet	
3	"	"	"	"	"	108.6	104.3					4th Jet	
4	1 Jet	3-400'	3-Apr	13:19	Gen Rad 1982			99.2					
4	"	"	"	"	162 SEL	102.5	100.5						
5	2 Jets	?	3-Apr	14:23	162 SEL	100.5	98.2					1st Jet	
5	"	"	"	"	"	79.8	81.2					2nd Jet	
5	"	"	"	"	Gen Rad 1982			102					
5	"	"	"	"	B&K 2230	103.9	105.9						
5	"	"	"	"	DAT	99.5		103.4 (SEL)	104.5	102.1			Footnote #1
6	1 Jet (?)	2-3000 km SD	3-Apr	15:40	DAT				84.9		11 CPA		
7	2 Jets	> 1000'	4-Apr	10:50	162 SEL	91.5	86.1				12,13 CPA	1st Jet	
7	"	"	"	"	"	88.6	86.6					2nd Jet	
7	"	"	"	"	"	79.6	79.2					Burners(?)	
7	"	"	"	"	Gen Rad 1982			94.6					
7	"	"	"	"	B&K 2230	92.2	86.6						
7	"	"	"	"	DAT	91.7		99.5 (SEL)	100.2	90.6			
8	3 Jets	?	4-Apr	11:31	162 SEL	115.8	113.4				14,15		
8	"	"	"	"	Gen Rad 1982			120.5					
8	"	"	"	"	B&K 2230	115.7	115.1						
9	1 Jet	1km SD	4-Apr	18:12	162 SEL	80.6	80.3						
9	"	"	"	"	Gen Rad 1982			78.3					
9	"	"	"	"	B&K 2230	80.6	80.6						
9	"	"	"	"	DAT	Too Faint							
10	1 Jet	3-5000'	4-Apr	18:56	Gen Rad 1982			74.5					
11	2 Jets	?	5-Apr	8:40	162 SEL	96.5	91				18 CPA		

11	"	"	"	"	"	84.6	81.4				19		
11	"	"	"	"	"	89.7	86.7						
11	"	"	"	"	"	86.7	84.6						
11	"	"	"	"	Gen Rad 1982			97.9					
12	2 Prop Planes	?	5-Apr	9:40	162 SEL	89.5	89.3				20 CPA 21		
12	"	"	"	"	Gen Rad 1982			95.6					
C	High Jet	?	5-Apr	10:10	162 SEL	Did Not Trig					22		
C	"	"	"	10:10	Gen Rad 1982			79.6					
D	C-130	"	5-Apr	11:01							23 CPA,24		
13	4 Jets	"	5-Apr	11:56	162 SEL	108.1	103.2						
13	"	"	"	"	"	104.1	104.1						
13	"	"	"	"	"	89.5	85.5						
13	"	"	"	"	"	102.2	98.4						
13	"	"	"	"	"	81.5	80.2						
13	"	"	"	"	Gen Rad 1982			107					
13	"	"	"	"	B&K 2230	109.5	104.6						
13	"	"	"	"	DAT	109 (ASEL)		112.2 (CSEL)	112.3 (TSEL)	105.5		1st Jet	Footnote #2
13	"	"	"	"	"	100.7		105.1 (CSEL)	105.2 (TSEL)	105.7		2nd Jet	
13	"	"	"	"	"					106.1		3rd Jet	
13	"	"	"	"						100.3		4th Jet	Footnote #3
14	2 Jets	500'	5-Apr	14:11	162 SEL	95.6	92.4						
14	"	"	"	"	Gen Rad 1982			95.8					
14	"	"	"	"	B&K2230		91.3						
15	C-130	1-2km SD	5-Apr	15:10	Gen Rad 1982			81.1			25,26 CPA		
15	"	"	"	"	B&K 2230		72.6						
16	Artillery	?	5-Apr	15:38	DAT	Not Heard							
17	2 Jets	4-500'	5-Apr	14:37	162 SEL	86.3	85.4				27,28,29		
17	"	"	"	"	"	81.8	80				28 = CPA		
17	"	"	"	"	Gen Rad 1982			86.7					
17	"	"	"	"	B&K 2230	87	82.4						
17	"	"	"	"	DAT	89.7		95.4 (CSEL)	95.9 (TSEL)	84.2	30 = CPA		
18	1 Jet	?	5-Apr	17:28	Gen Rad 1982			85.3					
18	"	"	"	"	B&K 2230	79.5	76.7						
19	2 Jets	3-400'	6-Apr	8:32	162 SEL	100	95.9				31-CPA, 32		
19	"	"	"	"	"	88.2	88.6				33 - CPA #2		
19	"	"	"	"	"	84.3	82.5						
19	"	"	"	"	"	90	86.7						
19	"	"	"	"	"	107.9	103.7						
19	"	"	"	"	B&K 2230	105.1	99.4						
20	2 Jets	4-500'	6-Apr	8:55	162 SEL	87	81.8				34 CPA east		
20	"	"	"	"	"	83.4	81.9						
20	"	"	"	"	"	102	98.3						
20	"	"	"	"	Gen Rad 1982			102.2					
20	"	"	"	"	B&K 2230	105.1							

21	3 Jets	2-300'	6-Apr	10:29	162 SEL	112.4	107				2 1st Jet		
21	"	"	"	"	"	81	81.2				3 - CPA #2		
21	"	"	"	"	Gen Rad 198			114.1					
21	"	"	"	"	B&K 2230	111.7	108						
21	"	"	"	"	DAT	107.3 (ASEL)		111.6 (CSEL)	111.7 (TSEL)	108.7		1st Jet	Footnote #4
21	"	"	"	"	"					112.4		2nd Jet	Footnote #5
21	"	"	"	"	"	109 (ASEL)		113.1 (CSEL)	113.2 (TSEL)	112.3		3rd Jet	Footnote #6
22	2 Jets	5-600'	6-Apr	10:38	162 SEL	87.7	85.2					Jets	
22	"				"	84.7	85					Burners	
22	"	"	"	"	"	87.6	84.5					"	
22	"	"	"	"	"	80.3	82.8					"	
22	"	"	"	"	Gen Rad 198			91.2					
22	"	"	"	"	B&K 2230	91.5	84.5					Jets	
22	"	"	"	"	DAT	90.6	86.5	97 (CSEL)	97.5 (TSEL)			Jets	
23	2 - Twin Props	200'	6-Apr	13:58	Not detected over wind								
23b	Helo	200'	6-Apr	14:00	162 SEL	Did not trigg					2--5		
23b	"	"	"	"	Gen Rad 198			82.2			6,7		
23b	"	"	"	"	B&K 2230	76.7	81.3						
23h	"	"	"	"	DAT	Hidden in wind							
24	Helo (Power Co)	150'	6-Apr	14:06	162 SEL	88.2	82.2						
24	"	"	"	"	Gen Rad 198			91.7			8,9		
24	"	"	"	"	B&K 2230	88.6	83.1						
24	"	"	"	"	DAT	88.9 (ASEL)		96.7 (CSEL)	97.5 (TSEL)	90.7			
25	2 - Twin Props	250'	6-Apr	14:09	162 SEL	81.6	81.3				10,11		
25	"	"	"	"	"	83.5	82.4				12-2nd Plane		
25	"	"	"	"	Gen Rad 198			93.1					
25	"	"	"	"	B&K 2230	82.2	77						
25	"	"	"	"	DAT	88.6 (ASEL)		99.1	99.5 (TSEL)				

Footnote 1:Duration is > 23 s - Onset rate was calculated from current ambient of 66.2 d peak of 102.1(?) 5% to 95% occurred in 3.15s - detection to peak was 3.43s.

ootnote #2First three jets only for DAT SEL and Max Measurements Duration is ?? Onset = 2.32s

ootnote #3Fourth Jet only for DAT SEL and Max Measurements

Footnote #4Onset = 2.85s for 1st Jet

Footnote #5Onset = 4.5 s for 2nd Jet

Footnote #6Onset = 3.2s for 3rd Jet

APPENDIX G

SURVEY RESULTS

SURVEY

In order to get a sampling of turkey producer experiences with stampeding and piling, a questionnaire was developed. The questionnaire was written by Francine A. Bradley and then reviewed by Dr. Christine Bruhn, Cooperative Extension Marketing-Consumer Science Specialist. The questionnaire was to elicit unbiased comments from producers regarding the incidence of stampeding/piling, resulting injuries/mortality, the environment in which it occured, and the producers' opinions as to the cause(s). Dr. Bruhn's critique of the questionnaire format eliminated any questions that might have biased the responses.

Summary

This survey cannot be considered the final word in terms of industry experiences. Given time limitations, it was impossible to survey more growers. Personal interviews would undoubtedly have elicited more information. However, the responses obtained do give insight into gowers' experiences with the problem of stampeding/piling.

Of the 36 individuals at the May California Turkey Conference, 13 completed the questionnaire and indicated experiences with stampeding/piling. The frequency of this occurrence was: once (1), twice (1), occasionally (1), not often (1), 4 or 5 (1), 5-6 (1), many times (3), 10-15 or more (1), no response (3).

Operations where piling had occurred included: brooder house (10), grow-out barn (6), breeder barn (4), range pen (7), and dark house (1). These responses should not be interpreted as meaning that the incidence of piling is always the highest in brooder houses. It may have been that the majority of respondents had more experience with brooder operations. Likewise, it cannot be assumed that piling is rare in breeder barns. There are relatively few breeder operaions compared to meat operations, so it is likely that more of the respondents were familiar with meat operations. As for the range pens, young industry members would not have experience with this old style of bird management. It can be said, however, that stampeding/piling has occured in all the types of management systems we asked about.

Of those experiencing piling, 6 had seen it in the evening only, 6 both in the day and evening, no one had seen it just in the day time, and one individual did not respond.

Numbers of birds involved in a pile/stampede ranged from 1 to 16,000. The mortality figures ranged from 1 to 6,000. In addition to mortality, there were a variety of injuries listed: broken legs (3), broken wings (4), scratches (3), and internal injuries (1). Others indicated difficulty in identiifying injuries and there were 2 no responses.

Presumed causes of the stampede were:

Dogs (3)
Coyotes (1)
Hawks (1)
Predators (7)
Loud noise (7)
Strangers (1)
Rain and wind, hail storm (4)
Power failure (1)
Airplane (1)
Crop duster (2)
Aspergillosis (2)
Medication/over medication (2)
Lights (3)
Ventilation problem (1)
Lack of water (1)

The questionnaire was distributed by John Voris (Cooperative Extension Turkey Specialist) at the May 9, 1990 meeting of the California Turkey Forum. This is the largest monthly meeting of turkey producers in California. Mr. Voris asked for the attendees' cooperation in filling out the questionnaires. Some individuals expressed concern that the survey had to do with animal rights. Mr. Voris had been instructed not to describe the research project for fear that it would plant the idea of aircraft as the cause of turkey stampeding/piling.

Completed questionnaires were collected by Mr. Voris and forwarded to UC Davis. The responses (copies encl.) have been coded to protect client identity. Attendance at the Forum on May 9th was 36. 13 individuals filled out the questionnaire. Initial screening of the questionnaires showed that all respondents had experiences with stampeding/piling. It can be assumed that at least some of the other producers present had never experienced stampeding/piling and felt their negative responses would not be of interest.

Those responding represented: employees of or contract growers for the four large turkey integrators in California and individuals with experiences at turkey breeding (as opposed to meat turkey) operations. There experiences were from turkey operations in the following counties: Fresno, Santa Clara, Sonoma, Stanislaus, and Tulare.

Responses have been summarized by question:

SUMMARY OF INDUSTRY QUESTIONNAIRE RESPONSES

Have you ever had turkeys stampede or pile?

Code	Response
vj	yes
bd	yes
cb	yes
cp	yes
nf	yes
fr	yes
cr	yes
fr	yes
gb	yes
ss	yes
sh	yes
sr	yes
ad	yes

If yes, how often?

Code	Response
vj	many times
bd	please call*
cb	many times
cp	occasionally in brooder house
nf	5-6
fr	4 or 5
cr	one time for one brood
fr	twice
gb	no response
ss	10-15 or more
sh	not often
sr	no response
ad	no response

"bd" only wrote "please call" on his form. I did a follow-up telephone interview and obtained the following information:
His experiences come from 10 years as a grow-out manager for several companies. He has seen stampeding/piling in both brooder and grow-out houses. The problem usually occurred between the hours of 6 PM and 6 AM. The number of birds involved was difficult to estimate. Mortality ranged from teens to couple of hundred. There were birds that were not killed. In general, they had leg problems, down on their legs, broken hips, or broken wings. He had identified a variety of causes for the stampeding: dogs or coyotes at end doors of building; strangers (theives) coming into the building; feed delivery trucks; lights from nearby road shining into the building; feed belt noise into the dark building; a ventilation "mess up" where the ventilation went off and the birds piled near a source of fresh air (e.g. crack in a door); loss of heat source in a brooder house; and in tom flocks suffering from Aspergillosis - one bird would die of cardiac arrest in the middle of the night and other birds around it would also die (a ripple effect; admits it wasn't actually piling).

Describe the operation

Code	Response				
vj	Brooder House			Range Pen	Dark House
bd	Brooder House	Grow-Out Barn			
cb	Brooder House	Grow-Out Barn		Range Pen	
nf	Brooder House		Breeder Barn	Range Pen	
cp	Brooder House				
fr			Breeder Barn	Range Pen	
cr	Brooder House				
fr		Grow-Out Barn			
gb	Brooder House	Grow-Out Barn	Breeder Barn	Range Pen	
ss	Brooder House	Grow-Out Barn	Breeder Barn	Range Pen	
sh	Brooder House				
sr	Brooder House	Grow-Out Barn		Range Pen	
ad	No response				

Did it happen during the day or evening?

Code			
vj			X
bd			X
cb		X	X
nf		X	X
cp		X	X
fr		X	X
cr			X
fr			X
gb			X
ss		X	X
sh			X
sr		X	X
ad	no response		

Approximately how many birds were involved?

Code	Response
vj	Brooder house - small #'s; & would be some stoves only - ea. stove had 350- 20 or 30 would pile Range pen - 8,000 - 8 wk poults at night time - we lost about 6,000 in a wind and rain storm right after they had been ranged. Dark house - 2,000 females piled at night. Were frightened and piled at end of house. 500 died.
bd	Difficult to estimate
cb	?
nf	Example 1-time 7,000
cp	.2%-.4%
fr	20,000
cr	300+-
fr	16,000 (2 barns)
gb	From 50 to several hundred
ss	10 to 8,000
sh	20 to 50 mortality
sr	1 - 55,000
ad	no response

Was there mortality?	NO	Yes	If yes, how many?
Code			
vj		X	6,000 on range; 500 in dark house
bd		X	Teens to couple of hundred
cb		X	?
fn		X	650
cp		X	.2% - .4%
fr		X	100 to 200
cr		X	80 - 100 can't remember
fr		X	700 - 750
gb		X	from under 10 to several hundred
ss		X	10 to 8,000
sh		X	20 to 50
sr		X	1 to 500
ad			no response

Were birds hurt but not killed? Code	No	Yes
vj		Some, scratches, broken wings, legs
bd		Leg problems, broken hips, broken wings
cb		Lack of air
nf		Scratched, torn
cp	X	
fr		Scratches, some broken wings
cr		Hard to tell. Some latent mortality
fr	no response	
gb		Broken limbs, internal injuries
ss		Very few, most are usually killed in a pile-up
sh		Unknown injuries
sr		1-500 injured
ad	no response	

Was the cause of the stampede determined?

No Yes - Predator Loud Noise Other

Code	
vj	Sometimes. Dogs have piled turkeys of all ages. Hawks have scared, but not mortality? Rain & wind - new, fragile poults from brooder house
bd	Dogs, coyotes, strangers, feed trucks, roadway lights, feed belt noise, ventilation problem, loss of heat in brooder house, Aspergillosis.
cb	Predator, loud noise, airplane, med.
nf	Predator, lights
cp	Predator? Is hard to know. Could be temp. too hot or too cold. We surmise in some cases a predator. We have had dogs and coyotes get in and no stampede.
fr	Dogs, loud noise, crop dusters - hail storm on tin roof.
cr	Predator. May have also had another pile up due to loud noise but can't remember and manager at time is no longer with us.
fr	Birds were suffering from aspergillosis in both instances. Both happened on hot, still evenings. (June 1986, July 1987). A bird would have a heart attack which caused birds to scatter, being rather nervous. Then it seemed to cause a change reaction. This went on for several hours (9:00 PM - 12 AM). Actually the "stampede" continued until close to dawn.
gb	Predator, loud noise. Startled by lights being turned on at night,.
ss	Predator, loud noise. Storm, power failure, out of water, too cold and too hot.
sh	Poor management of brooder stoves.
sr	Predator, loud noise, mismanagement, storms, crop dusters, over medication, over heating.
ad	All kids

Brooder stove mismanagemnent (5)

The responses received to the final question indicate the variety of causes that have been identified as the culprits in turkey stampedes. Crop dusters and planes did not lead the list of causes.

The "medication" responses were intriguing. Further investigation revealed that some producers have experienced problems with nitrofurazone. This medication is given to turkeys (and chickens) for the prevention of coccidiosis and to assist in the control of secondary bacterial infections that may appear with coccidiosis. One producer described situations where the drug was administered in the drinking water and seemed to intoxicate the birds. The opposite response, making birds hypersensitive, was seen in other flocks given the nitrofurazone. In the latter group, a sudden change -such as a wild bird flying by outside the barn-caused the turkeys to stampede.

Growers were more likely to blame themselves or their machines for poor environmental conditions or blame outside factors such as predators, dogs, strangers, or acts of God, rather than the overflight of a plane. Undoubtedly, there could be compounding causes, e.g., birds in a poorly managed brooder house during the winter storm season.